Standards for Evaluating Photographic and Cinematic Lenses

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Research Summary

Abstract:

For a camera, the lens is the eye. It collects the light rays reflected to it from the scene being photographed, to create an image of this scene on the surface of the film or camera sensor. Thus, there is no way to obtain a good image, whether standing still or moving, without using a highly efficient lens. If the light rays reflected from the photographed scene and pass through a lens with poor optical performance, the camera, whatever its efficiency and its sensor, will not be able to produce a good image. The truth is that not all lenses are optically optimal, meaning that the light transmitted through them has an inevitable percentage of loss due to the reflections on the multiple glass surfaces that make up the lens. Which necessitates the need to fully understand the nature of the lenses used in cinematography, and the various problems encountered in obtaining a high-quality image. It also increases the importance of assessing and testing the lens's efficiency and its ability to convey the details of the captured scenes in objective ways. The research problem lies in the fact that failure to evaluate the lens may cause many problems that negatively affect either the use of the lens during shooting, or the quality of the images that we get with this lens, such as: The problem of the difficulty of using the lens due to poor design. And the problem of the lens's lack of ability to translate the contrast of the photographed scenes, and its poor resolution. As well as the heterogeneity of the optical performance of the lens from its center to its edges. Therefore, the research aims to examine the criteria for evaluating the lenses used in photography and cinematography, whether those related to the efficiency of the design and movement of its various mechanisms, or those that relate to the efficiency of the optical performance of the lens such as: lens speed, resolution, contrast, sharpness, and maximum depth of field, as well as the absence of lens defects that negatively affect the images formed by it.

Keywords:

Photographic Lenses, Cinematic Lenses, Evaluating Lenses, Lens Speed, Lens Contrast, Lens Resolution, MTF Charts, Circle of Confusion.

Introduction:

For a camera, the lens is the eye. It collects the light rays reflected to it from the scene being photographed, to create a picture of this scene on the surface of the film or camera sensor. Thus, there is no way to obtain a good image, whether still or motion image, without using a highly efficient lens. If the light rays reflected from the photographed scene pass through a lens with poor optical performance, the camera, whatever its efficiency and its sensor, will not be able to produce a good image.

The truth is that not all lenses are optically optimal, meaning that the light transmitted through them has an inevitable percentage of loss due to reflections on the multiple glass surfaces that

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make up the lens, as well as on the internal mechanical surfaces of the lens. Each of the glass surfaces that make up the lens reflects a portion of the light that falls on it and does not perform it. This loss of light increases in the case of zoom lenses, because it contains many glass surfaces forming it.

The quality of lens performance does not come by chance, but rather is a product of good design, taking into account the smallest details in the manufacture of glass surfaces that consist of it, and the development of materials used in coating, and work to correct its defects in the best way, so that we get the best possible results from them. Which necessitates the need for a full understanding of the nature of the lenses used in photography, and the various problems encountered in obtaining a high-quality image. It also increases the importance of assessing and testing the lens's efficiency and its ability to convey the details of the captured scenes in objective ways.

There are many elements that the lens is evaluated based on, including those related to the mechanical properties of the lens, such as: the durability of the materials used to make them, the smoothness and homogeneity of movement of the aperture control mechanisms, focusing, focal length and image stabilization. Including what relates to the efficiency of its visual performance, such as: the lens speed, resolution, contrast, depth of field, and how far it is free from lens defects that negatively affect the images formed by it, such as chromatic aberration, vignette, distortion, breathing and flare.

Therefore, we will study in this research all the factors affecting the quality of the lens and the efficiency of its mechanical and optical performance, in order to find out the criteria for evaluating the lenses used in photography or cinematography, to obtain the maximum possible image quality.

Problem statement

Failure to evaluate the lens before using it in shooting may cause many problems that negatively affect the use of the lens during shooting, or the quality of the images that we get with this lens, as follows:

- The problem of difficulty using the lens due to poor design, either to shorten the path of the focusing ring, or the lack of smoothness, and homogeneity of the movement of the control rings in the aperture and focusing and focal length.
- The problem of the loss of light penetrated from the lens due to the light reflections on the glass surfaces forming it.
- The problem of the lack of the lens's ability to translate the contrast of the photographed scenes, and its poor resolution strength.
- The problem of the heterogeneity of the optical performance of the lens from its center to its edges.
- The problem of the negative impact of lens defects on the images it produces.

Aims and objectives

The research aims to determine the criteria for evaluating the lenses used in photography and cinematography, whether those related to the quality of the lens construction, the efficiency of the design and movement of its various mechanisms, or those that relate to the efficiency of the optical performance of the lens such as: the speed of the lens, resolution, contrast, sharpness, and maximum depth field to it, as well as free from defects of the lenses that negatively affect the images created by it, in order to obtain the maximum possible quality of the photographic or cinematic image.

Methodologies

The research follows the descriptive analytical method by studying all the factors affecting the quality of the lens and the efficiency of its mechanical and optical performance, in order to determine the criteria for evaluating the lenses used in photography and cinematography.

Conclusions

- All lenses are not optically optimal, as it is virtually impossible for the lens to reach 100% of the light transmitted by them, due to the reflections on the multiple glass surfaces that make up the lens. This loss of light increases in the case of zoom lenses because it contains many glass surfaces forming them.
- The lens glass surfaces are coated with materials that reduce the loss of light passing through the lens, increasing the amount of light transmitted, thereby increasing the speed of the lens. These coatings also reduce flare, increasing image contrast. Without these coatings, the lens will have practically no value.
- Most telephoto and zoom lenses include anti-shake feature, which allows shooting at slower shutter speeds while holding the camera in hand, while preserving image sharpness, without any vibration.
- The value of f – stop is an engineering relationship between the length of the focal length and the length of the aperture diameter, and therefore it does not take into account the amount of light lost inside the lens, and the value of T – stop is more accurate to express the light transmitted from the lens, because it is calculated for each lens individually, depending on the amount of light actually transmitted from the lens. Therefore, the value of f – stop is used in depth field calculations, while T – stop is used when calculating exposure. Usually, the value of T – stop is less than the value of f – stop specified on the lens by the equivalent of 1/2 or 1/3 f-stop, and this difference increases in the zoom lenses, sometimes reaching a full aperture.
- Each lens has an optimum range of f – stop values that give the sharpest image, this range usually starts from two narrower lens apertures than the widest aperture, and usually reaches f / 11. In other words, the best f – stop values that can be used to obtain the maximum possible sharpness in the image, are the values that mediate the range of apertures that the lens allows. Any value above or below this range will produce images of relatively low sharpness.
- The speed of the lens is determined by the widest aperture that it can be photographed, which is expressed with the lowest f-stop value written on the lens, and the higher the speed of the lens, the more it can be used for shooting in low-light conditions. Increasing the speed of the lens does not necessarily mean that the efficiency of its optical performance is higher than that of slower lenses, but it only means that it allows shooting in lower lighting conditions. Therefore, if the lens will not be used in low-light conditions that require a very wide aperture, we should not consider the high-speed standard when choosing the lens used for shooting.

- The lens is at its best optical performance at its center, whether in terms of resolution, sharpness, or contrast, and the further we move away from the center of the lens, the lower its performance, to reach the worst possible level at its edges.
- The resolution is defined as a measure of the lens's ability to reproduce the very fine details of the subject being photographed. And the lens's ability to distinguish these subtle details is subjected to their ability to translate the contrast between these details, so that they can be distinguished in the picture. The less the lens is able to transmit the contrast of the original subject to the image, the less its ability to distinguish the fine details of this subject, and therefore the less its resolution.
- The MTF diagram is used to draw an integrated picture of the efficiency of the optical performance of the lens in transmitting contrast and the resolution, as it measures the lens's ability to transmit details, the higher the number of lines depicted in millimeters. It also measures the performance efficiency of the lens over its diameter from the center to the ends.
- The circle of confusion value determines the largest circle that the image of the point in the original scene can reach, so that the eye distinguishes it as a point and not a circle, and if the area of this circle exceeds the value of the confusion circle, the eye will distinguish it as a Circle, lose its sharpness and lose its details. It is the value upon which the maximum depth of field of the lens is determined.
- The term bokeh is used to express aesthetic properties in the appearance of out of focus parts in the image. One of the important elements in assessing lens quality is the appearance of blurred parts in areas outside of clarity. Where the lens is considered to be a good bokeh effect, if the out of focus circles that produce it, have a high brightness in the center, and gradient in darkness as we go to the edges, then the circles are smoothly consistent with the surrounding environment. If the blurred circles produced by the lens are homogeneous, or worse if their edges are of high brightness, and their center is dark, the blur effect of the lens is described as bad bokeh.
- <u>When assessing the lens by reading the MTF chart, keep the following in mind:</u>
- The higher the curves in the diagram, the better the optical performance of the lens, whether in its transfer of contrast, or in the resolution.
- The lower the speed of the curve's slope, while it is pointing to the right, this indicates that this lens performs better in transmitting the contrast, and resolution at the edges.
- As the continuous curve approaches the intermittent curve, this means that the performance of the lens is close to both types of oblique lines at different angles, which makes the bokeh effect on images of this lens better. Also, the background blur is better when out of focus.
- The MTF chart provides valuable information about the lens's resolution, and how well it transmits the contrast, but it still does not give us enough information about other lens properties, which affect the quality of its images, such as optical aberration, either linear or chromatic, as well as flare.
- It is not correct to make comparisons between the MTF diagrams of different lenses in their focal length, because curves expressing lenses with a wide focal length will be steeper as we go to the right, unlike telephoto lenses, the degree of which is the slope of their curves less. Therefore, comparisons should only be made between schemes of similar lenses in their focal length.

- MTF charts should not be compared to the lenses produced by different companies, except after knowing the standards that each company follows in measuring and testing its lenses, because there may be important differences between one company and another in the types of test boards that are photographed, the thickness of the lines and other factors that Comparing different company plans may be very useless.

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