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DESIGN AND ANALYSIS DIGITAL CAMERA LENS USING ZEMAX PROGRAM

Haider Y. Hammod*[1], Intisar A. Naseef[2] , Saaid F. Hassan[3]
[*1,2&3]Ministry Of Science And Technology/Directorate Of Material Research /Center Of Laser Research

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ABSTRACT
The objective of this study is to design and analysis of Digital camera Multiple Lens Reflex (DMLR) cameras design and analysis using the Zemax software.A wide range of wave length extends from (0.486- 0.656) μm and diffraction limited over a large field of angles with F/#2.9 also studied. We found these the performance is very close to the predicted values of aberrations. which selected with limited magnification that may be used for photography.

KEYWORDS: digital camera lens, design camera lens, zemaxprogram.

I. INTRODUCTION
A camera lens may be made from a number of elements: from one, as in the Box Brownie's meniscus lens, to over 20 in the more complex zooms. These elements may themselves comprise a group of lenses cemented together. The front element is critical to the performance of the whole assembly. In all modern lenses, the surface is coated to reduce abrasion, flare, and surface reflectance, and to adjust color balance. To minimize aberration, the curvature is usually set so that the angle of incidence and the angle of refraction are equal. In a prime lens this is easy, but in a zoom, there is always a compromise [2].The reason for the optional digital camera instead of a regular camera isthe major difference is that SLR, Single Lens Reflex has pentaprism and mirror which reflects lens image back to the viewfinder. In simple words, you will capture anexact image, which you can see through the Viewfinder of SLR Camera.
On the other hand, thenormal camera has electronic or LCD viewfinders which are offset from the lens and doesn’t match the viewfinder image.Glass is the most common material used to construct lens elements, due to its good optical properties and resistance to scratching. Other materials are also used, such as quartz glass, fluorite,[3-6].plastics like acrylic (Plexiglass), and even germanium andN-SK2.[7] Plastics allow the manufacturing of strongly aspherical lens elements which are difficult or impossible to manufacture in theglass, and which simplify or improve lens manufacturing and performance. Plastics are not used for the outermost elements of all but the cheapest lenses as they scratch easily. Molded plastic lenses have been used for the cheapest disposable cameras for many years, and have acquired a bad reputation: manufacturers of quality optics tend to use euphemisms such as "optical resin" [10].

II. THEORY OF OPERATION
A camera lens (also known as photographic lens or photographic objective) is an optical lens or assembly of lenses used in conjunction with a camera body and mechanism to make images of objects either on photographic film or on other media capable of storing an image chemically or electronically. There is no major difference in principle between lenses used for a still camera, a video camera, a telescope, a microscope, or other apparatus, but the detailed design and construction are different. A lens may be permanently fixed to a camera, or it may be interchangeable with lenses of different focal lengths, apertures, and other properties. While in principle a simple convex lens will suffice, in practice a compound lens made up of a number of optical lens elements is required to correct (as much as possible) the many optical aberrations that arise. Some aberrations will be present in any lens system. It is the job of the lens designer to balance these out and produce a design that is suitable for photographic use and possibly mass production [8].

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Typical rectilinear lenses can be thought of as "improved" pinhole "lenses". As shown, a pinhole "lens" is simply a small aperture that blocks most rays of light, ideally selecting one ray to the object for each point on the image sensor. Pinhole lenses have a few severe limitations:

- A pinhole camera with a large aperture is blurry because each pixel is essentially the shadow of the aperture stop, so its size is no smaller than the size of the aperture (below left). Here a pixel is the area of the detector exposed to light from a point on the object.
- Making the pinhole smaller improves resolution (up to a limit), but reduces the amount of light captured.
- At a certain point, shrinking the hole does not improve the resolution because of the diffraction limit. Beyond this limit, making the hole smaller makes the image blurrier as well as darker (see the figure below).

Bymodern types, we mean lens forms that were found on cameras in 1992. The chapter dealsalmost entirely with lenses for the format. This limitation isunfortunate but not really inappropriate, given the widespread use of this format.We have not included any specific design examples of lenses for large-format cameras,but the imaging capabilities of these lenses are described in terms of digital applications.By digital applications, we mean the comparison of different lens types in terms of totalpixels and pixels per unit solid angle. See ‘‘Further Reading’’ at the end of this chapter forrelated information about photographic lenses, particularly with respect to older design types.

Aperture and Focal Length:Aperture is the hole through which light travels, it regulates the amount of light that passes to form the image,Focal length (specified in millimeters (mm)) is a measure ofhow strongly the system converges (focuses) light, It also determines the distance to the objective that is photographedF-number = f/D where f is the focal length and D is the diameterof the aperture.

The distance from the front focal point of the combined lenses to the first lens is called the front focal length (FFL):

$$\mathrm{FFL} = \frac{f_1(f_2 - d)}{(f_1 + f_2) - d}. \quad \ldots\ldots\ldots\ldots\ldots(1)$$

Similarly, the distance from the second lens to the rear focal point of the combined system is the back focal length (BFL):

$$\mathrm{BFL} = \frac{f_2(d - f_1)}{d - (f_1 + f_2)}. \quad \ldots\ldots\ldots(2)$$

$$F/\# = \frac{\text{focal length}}{\text{Entrance pupil diameter}} \ldots\ldots.(3)$$

$$F/\#_{\text{working}} = (1-m).F/\# \qquad \ldots\ldots\ldots(4)$$

Where,

M=magnification(usually negative due to image inversion).

and

=infinite F/# ……(5) $F/\# = \frac{focallength}{Entrancepupildiameter}$
F/#= (1+m).F/# …………..(6)

Which takes care of sign confusion?

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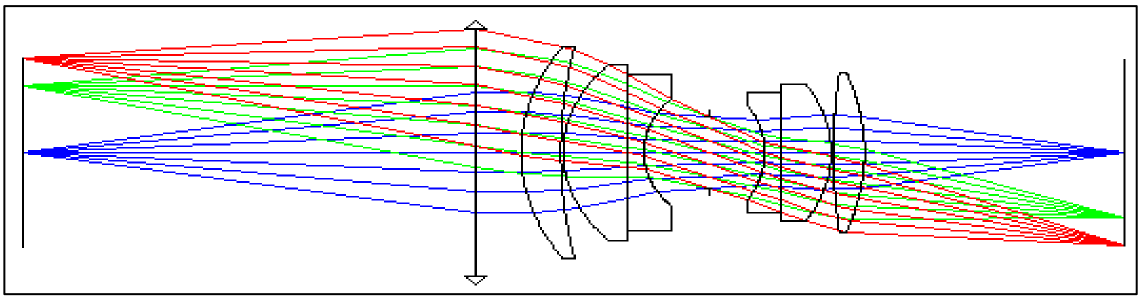
III. RESULTS AND DISSECTION

Fig (1) a set of lenses used and consists of twelve surface made of three materials are N-SK2, N-SK16, and F5, confined within a wavelength of (4.86 to 6.56) µm,This table -1,consists of twelve surfaces, the different types of metal **s**oftens,so that all the input data that represented in the figure below. The pixel counts are summed over all regions to yield the D data in table-1 the AD data in table-1 are obtained.The use of the high-index-of-refraction lanthanum crown glass (N-SK2) in this design helps to reduce spherical aberration.Has been designed using the program zemax[1].

Table(1) camera lens design

Surf:Type		Radius	Thickness	Glass	Semi-Diameter	Par1 (unused)	Par1 (unused)
OPJ	Standard	********	100.0		27.00	100.00	1
1	Paraxial	******	10.0		35.451		
2	Standard	54.153	8.747	N-SK2	30.256		
3	Standard	152.522	0.500		29.289		
4	Standard	35.951	14.00	N-SK16	24.916		
5	Standard	*******	3.777	F5	22.123		
6	Standard	22.270	14.253		15.174		
STO	Standard	*******	12.428		10.229		
8	Standard	-25.685	3.777	F5	13.587		
9	Standard	*******	10.834	N-SK16	17.239		
10	Standard	-36.980	0.500		19.676		
11	Standard	196.417	6.858	N-SK16	22.525		
12	Standard	-67.148	57.305		22.799		
IMA	Standard	*******	-		26.549		

This table consists of the number of surfaces for a lens which has three surfaces, radius of curvature, thickness and types of glass also using the aperture value of the objective lens. Therefore, from all the input data above we can see the results of the design as in below



Fig(1) the structure of the camera[1].

The camera consists of a set of lenses that collect light at the center. Through the use of a range of different lenses shape with the appropriate choice of materials Glass lenses (with coefficients of refraction different) , can thus avoid the disruption of radiation collected , (if you do not choose the lenses right leads to the production of the image is not clear bad contrast or separate colors of light in the picture The resulting, or Alachtlalin happen together).
Lens system is characterized by several statements:

- Aperture f It identifies the entry angle X-ray camera.
- The intensity of the rays passes lenses L, which gives the amount of light that enters the lens to the film when the aperture is open to the end. The measured intensity this topic number: L = d / f,

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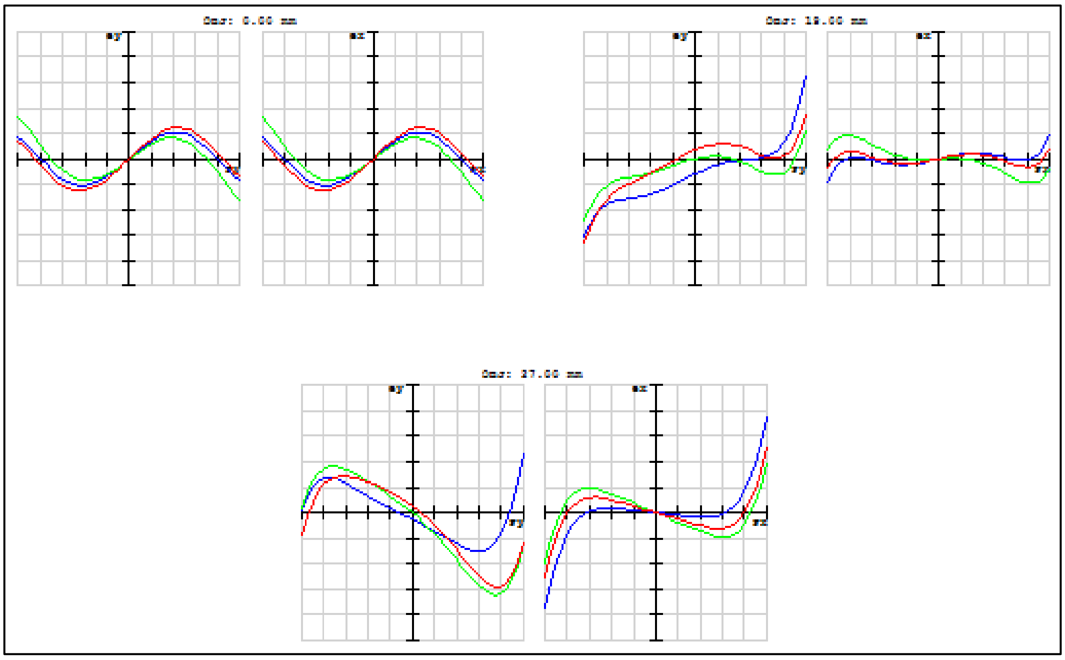
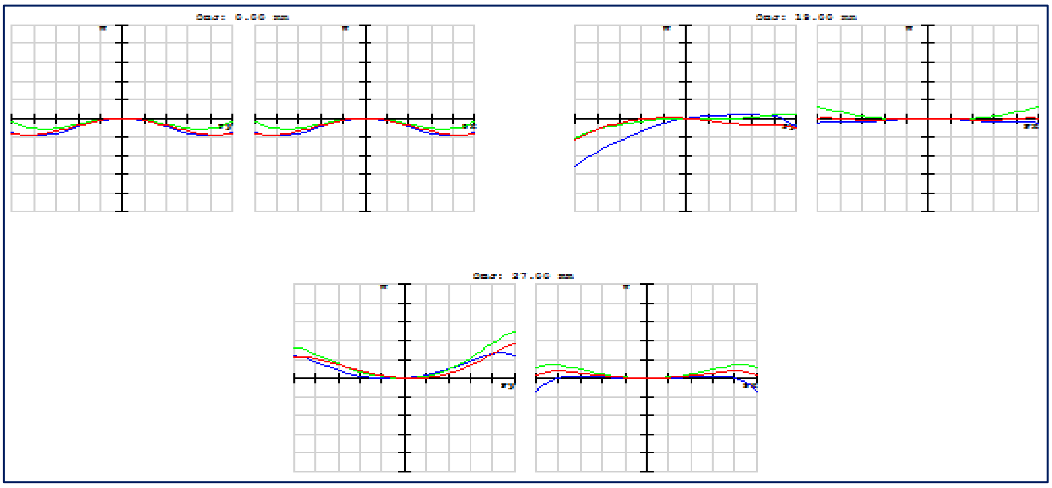
[Where d: diameter of the lens first (rays entering the lens), such as L = 1: 2,0.

The value total axial length (242.979mm).



Fig(2) the transverse ray fan plot[1].

For the above results, we can see that the aberration for the lenses design of camera lens can be represented by the figures in each design consider the ray intercept curves in fig-2, shows that transverse ray aberration of rays from an axial object point.The third set of curves as in Fig. (2) shows the aberrations of rays from an object point that is 27 degree.The maximum value of the curve±50µm andEach curve represents a wavelength curved green0.588µm, blue curve0.486µm, and curved red0.656µm,For the above results we can see that the aberration for the lenses design of camera lens can be represented by the figures in each design consider the ray intercept curves in fig-2, shows that transverse ray aberration of rays from an axial object point.in this plot, we have introduced two new terms(p_y)and (p_x) stands for "tangential section″ which refers to the section of the pupil in which the x-coordinates are zero. in the meridian plan,"s" is the sagittal section.Thisfigureshows the tangential and sagittal section varies with each other at the same time.we are considering plots of transverse ray aberration, the aberrations of the Meridian rays are proportional to y 3 and the aberration of the sagittal rays are proportional to x^3.



Fig(3) the optical path diffraction [1]

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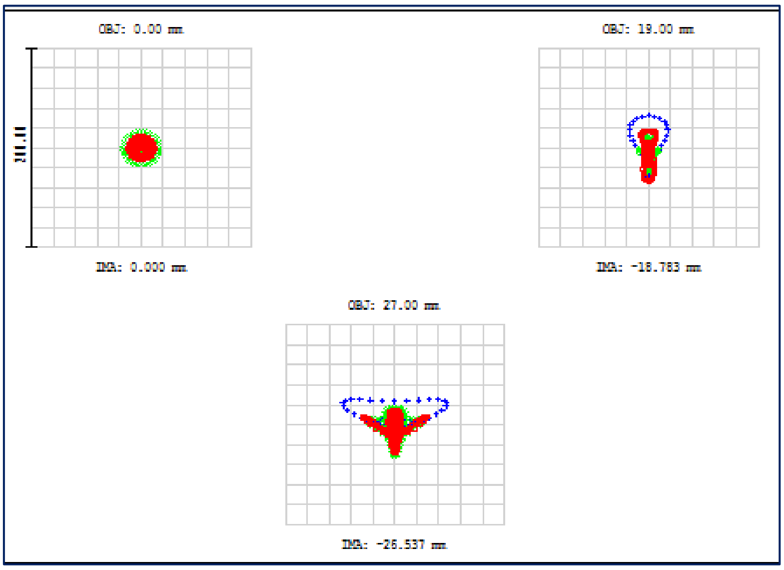
The Fig. (3) show plots of wave front aberration as a function of aperture. They are useful for lenses that are nearly diffraction limited, that is to say, their aberration is so small that resolution is limited by the finite size of the pupil, rather than by aberrations. In other words, the wave front aberrations are a small fraction of the wavelength of the light. We can now comment on some features of the transverse aberration curves and wave front aberration curves in Fig. (3). For instance, the area under the curve of as agittal transverse aberration for x>0 at 27degrees is clearly large From fig-5,Spot diagrams give little information about which parts of the entrance pupil particular rays pass through.We have in the figure above six areas and each area represents three curves and the curves represent in fig (3)the optical path difference illustrates curves passes through the system and note the curves and the area under the curves direction of ±X, the defects within acceptable spaces where the Y-axis represents,as well X-axis represents and the value maximum scale ±10 waves,Fromfig-5,Spot diagrams give little information about which parts of the entrance pupil particular rays pass through. In a perfect optical system, the optical path of the wavefront will be identical to that of an aberration-free spherical wavefront in the exit pupilIn addition to plots of the ray error in an evaluation plane , another aberration plot is one that expresses wavefront aberrations as an optical path difference (OPD) from a spherical wavefront centered about the image point . These OPD plots are particularly useful for applications where the lens must be close to dif fraction-limited.



Fig(4) spot size diagram[1]

Another method of obtaining information about the aberration of a lens is to plot spot diagrams. The typical output from a spot diagram calculation is shown in Fig-4. the results of eyepiece lens as the first design are used here. Each set in Fig-4, Represents the aberration at one position in the object so that the first set shows the aberration of rays from an axial object point while the second and third set in the same shows the aberration of rays from points that are 19 degrees and 27-degreeoff-axis respectively. The small bar in the top left of the plot shows the scale for the diagrams. From the above results, we can see that the aberration for the design objective microscope can represent by the figures in each design, In the fig-4 shows the number of light spots where each one of these spots represents entry rays within the design above.In the event that the field is zero, namely that, all very close to the rayaxis of the optical spot size is virtually free of defectsThe value of half a square spot rate,But when the fall of the field of radiation on the visual system, the optical spot as shown in the figure show their flaws, but within the allowable.In Fig-4, the camera is not diffraction limited for wavelength 486 nm.However, it is said to be diffraction limited for the other three wavelengths.We have in the figure above three fields ofRMS radius see Fig (4) found as 8.524,11.686and 16.835 microns,Also we havegeosynchronous equatorial orbit(GEO)radius 16.472,33.191and 52.188, scale bar200. we can see that the spot size has less aberration. The variation of effective with spot size also calculated and plotted. The value of (EFF) of design(81.2087),aperture type (float by stop size),apodization type Unifrom.

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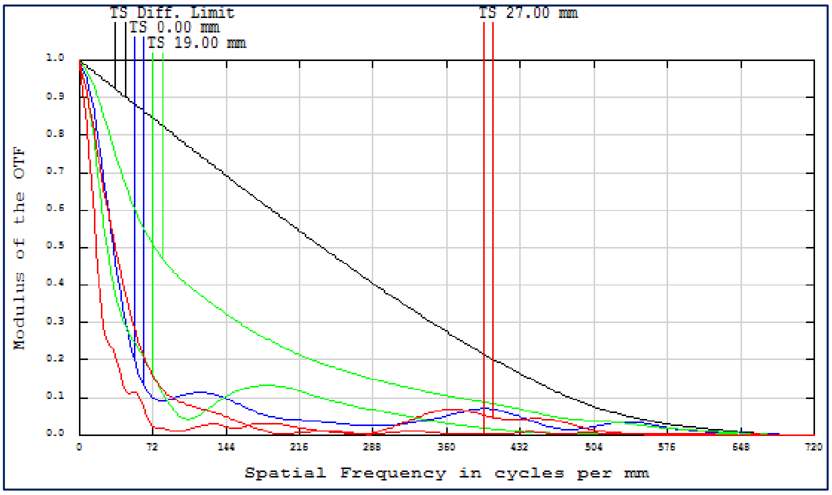

Fig(5) The diffraction MTF[1]

Fig-5 shows polychromatic diffraction MTF for these six lenses. Depending upon the testing conditions, both lenses can yield equivalent performance. This figure also indicates the designed camera's averaged values of MTF at wavelengths (0.486 to0.656)µm for the rays between the center of the optical axis and edge of the optical axis. A black curve which is the diffraction limited of this system shows the best performance. The rays come from the center of the optical axis provide the better performance than the edge of the optical axis.

IV. CONCLUSION

From all the results above, we conclude that this research used the of Digital camera and group lenses by composed of twelve surfaces are made of three materials are N-SK2,N-SK16, and F5, this design is very simple and used the reverse engineering. we obtain less distortion from the six lenses.From the above results, we can see that the aberrations for the Digital camera and objective can be represented by the figures in each design.Therefore,we described the geometrical aberrations by the transverse ray fan plot,And also we explainedthe optical path diffraction,spot size diagram, andthe diffraction MTF

V. REFERENCES

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