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Concentric Zones With Different Amplitude Filters

Dr. A. Narsaiah,
Principal, ABV Govt Degree College, Janagaon 506167, Telangana.
B. Srinivasa Goud,
C. Assistant Professor of Physics ABV Government Degree College, Jangaon Telangana -506 167. India.
Dr.T. Kiran Kumar,
Assistant Professor, Department of Physics, Brilliant Institute of Engineering and Technology Hyderabad – 501505.

Abstract**:** In optical systems the apodisation technique employing aperture shading is implemented in three different ways. The apodisation is affected over the entire pupil, The pupil is apodised over a limited zone and the pupil is divided into a specified number of concentric annular zones, each varying in transmission from the other. The second kind of apodisation is called the partial apodisation and the third kind is known as the variable apodisation which will form the subject matter of this. All through the study optical systems with annular apertures apodised with the amplitude filters, namely Hanning filter, Lancoz filter, Shaded aperture filter, Barlett filter and Butterworth filter of the first order have been considered. Investigations have been made on the imaging properties of defocused optical systems suffering from primary spherical aberration. The effects of variable apodisation on the diffracted field characteristics of apertures with Straubel class of pupil functions. In their study, they have divided the pupil into different number of concentric annular zones.

Keywords: Aberration, Aperture, Hanning pupil and annular zones etc;

I. Introduction

General mathematical formulation for the complex amplitude distribution in the defocused plane of apodised optical system in the presence of spherical aberrations has been presented. From the below expression the expression for complex amplitude in the case of variable apodisation with two filters when the aperture is divided into two concentric zones can be written as

$$G_F(\phi_d,\varphi_s,Z)=2\int_{\varepsilon}^{0.5} f(r)\exp\left[-i\left(\phi_d\frac{r^2}{2}+\frac{1}{4}\varphi_s r^4\right)\right]J_0(Zr)r\,dr \;+$$

$$G_F(\phi_d,\varphi_s,Z)=2\int_{0.5}^{1} f(r)\exp\left[-i\left(\phi_d\frac{r^2}{2}+\frac{1}{4}\varphi_s r^4\right)\right]J_0(Zr)r\,dr$$

Where f(r) is the amplitude filter. In the present study the following filters are employed:
Expression gives the complex amplitude PSF of an apodised optical system under the influence of defocus and primary spherical aberration. The intensity or irradiance PSF $B_F(\phi_d, \varphi_s, Z)$ is given by the squared modulus of the amplitude PSF. [5] discussed about a review paper which brings out a summary of popular image processing techniques in practice for students, faculty members and researchers in medical image processing field. Through Image processing, we do some operations on an image, to get an enhanced image or we try to acquire some useful information from it.

1.2 MATHEMATICAL FORMULATION:

$$B_F(\phi_d,\varphi_s,Z) = |\, G_F(\phi_d,\varphi_s,Z)\,|^2$$

Accordingly the intensity PSF in the Gaussian focal plane is given by,

$$B_F(0,\varphi_s,Z) = |\, G_F(0,\varphi_s,Z)\,|^2$$

In the defocused and aberration free plane the intensity PSF is

$$B_F(\phi_d,0,Z) = |\, G_F(\phi_d,0,Z)\,|^2$$

For a clear aperture or for a perfect lens, f(r) = 1. The expression for the normalized intensity at a specified point in the Gaussian focal plane becomes,

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$$I = \left[\frac{2J_1(Z)}{(Z)}\right]^2$$

Similarly, when the aperture is divided into five concentric zones with different amplitude filter in each zone, which in turn results in variable apodisation, the expression will be of the form:

$$2\int_{0.2}^{0.4} f(r)\exp\left[-i\left(\phi_d \frac{r^2}{2}+\frac{1}{4}\varphi_s r^4\right)\right] J_0(Zr)rdr \ +$$

$$2\int_{0.6}^{0.8} f(r)\exp\left[-i\left(\phi_d \frac{r^2}{2}+\frac{1}{4}\varphi_s r^4\right)\right] J_0(Zr)rdr \ +$$

$$2\int_{0.8}^{1} f(r)\exp\left[-i\left(\phi_d \frac{r^2}{2}+\frac{1}{4}\varphi_s r^4\right)\right] J_0(Zr)rdr$$

Where f(r) is the amplitude filter chosen. The intensity or irradiance PSF B_F (ϕ_d, φ_s, Z) is given by the squared modulus of the amplitude PSF.

1.3 RESULTS AND DISCUSSION:

β=0	0.2	0.4	0.6	0.8	1
7.6634	7.7542	7.8950	8.1488	8.8670	9
7.7514	7.8676	8.0575	8.4646	9.1890	9
7.8676	8.0318	8.3483	9.4096	12.4785	8
8.0256	8.2878	9.0806	11.1969	11.5769	7
8.2537	8.7517	10.1175	10.8499	11.2127	6
8.6139	9.4858	10.3154	10.7560	7.3289	6
9.1536	9.9182	10.4080	10.7276	6.8847	6
9.6240	10.1316	10.4745	7.2405	6.6050	6

	10.2673	7.7386	6.9006	6.4154	6.0516
	10.3691	7.2115	6.6761	6.2817	5.6172
	7.5860	6.9365	6.5167	6.1847	5.2852

Table gives the values of spot width which is the distance between first minima on good and bad sides. The variation in spot width for various combinations of 'β' values. It has been observed that the spot width initially increases with increase in 'β' in presence of the first minimum on both the sides moves first away from and then towards the diffraction head with the increase in ring width and increase in 'β' value. [7] discussed about Improved Particle Swarm Optimization. The fuzzy filter based on particle swarm optimization is used to remove the high density image impulse noise, which occur during the transmission, data acquisition and processing. The proposed system has a fuzzy filter which has the parallel fuzzy inference mechanism, fuzzy mean process, and a fuzzy composition process. In particular, by using no-reference Q metric, the particle swarm optimization learning is sufficient to optimize the parameter necessitated by the particle swarm optimization based fuzzy filter, therefore the proposed fuzzy filter can cope with particle situation where the assumption of existence of "ground-truth" reference does not hold.

Figs(1-6) are the image intensity distributions as function of z, the dimensionless diffraction coordinate, for different combinations of the separations of the two object points Z_0, the intensity ratios α, apodisation parameter β, degree of coherence γ. A dip in the curves indicates that the two objects are clearly resolved. When the dip point just vanishes, the two object points are just resolved according to the Sparrow criterion. In this position a part of the curve is parallel to the x-axis. The contrast is zero in this case. For this separation between the two object points, at the vanishing point, both the first and second derivatives of the intensity distributions vanish, satisfying the modified criterion as introduced by Asakura. When β=0, α=0.2, γ=0 are kept constant

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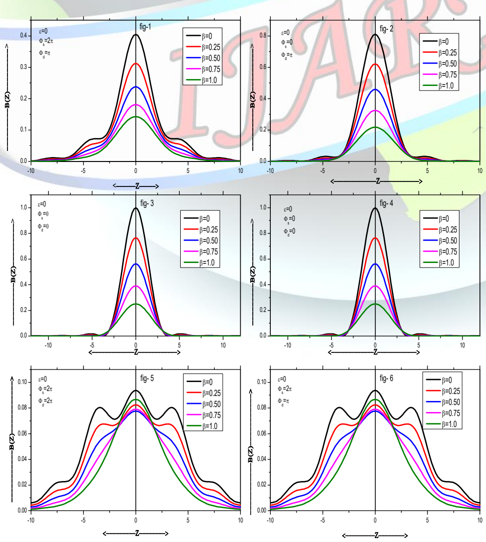
and the family of curves is for various Z_0 values varying from two to five. It is observed

1.4 CONCLUSIONS:

The phenomenon of diffraction and aberrations are the primary contributors in the degradation of image quality and affecting the performance of the optical system. The general feature of all the optical systems is the presence of optical aberrations. Even in most well corrected systems, there are some residual aberrations present. Aberrations results in phase errors in the wave front as it traverses the optical system. The presence of aberrations introduces undesirable results and unnecessary degradation in the performance of the optical systems. The study of imaging properties of optical systems suffering from aberrations from the knowledge of the point spread function has become an important method in the design and testing of such systems. These reasons have incited to explore the possibilities in enhancing the performance of the optical systems which forms the principal aim of the present work. In the present work, the main focus was on the effects of defocus, primary spherical aberration and two-zone apertures.



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