Nasir Ganikhodjaev
Farrukh Mukhamedov
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VOLUME 1

$$x' = 2xy$$
$$y' = 2xz$$

INVESTIGATIONS ON PURE MATHEMATICS, FINANCE MATHEMATICS AND OPTICS

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$$\varphi_1(x, y, z) = z$$

$$z' = x^2 + y^2 + z^2 + 2yz$$

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Investigations on Pure Mathematics, Finance Mathematics and Optics

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Part II Finance Mathematics Concentration

Part III Optics Concentration

THE OPTICAL RAY TRACING TECHNIQUE IN LENS SYSTEM WITHIN AND BEYOND PARAXIAL APPROXIMATION

Muhd Aizuddin Ali
Supervised by Assoc. Prof. Dr. Bakhram Umarov

Abstract. *The optical ray tracing technique is a technique to determine the location of ray propagation. The study of the optical ray tracing technique uses paraxial approximation because of the resulting point image, which is useful to explain the light behaviour after entering some optical devices. However, in designing optical devices or instruments, the technique has to develop beyond the paraxial approximation, in order to make sure that the image generated will be as precise as possible. This paper discusses the general calculation of the optical ray tracing technique, and the changes in paraxial and beyond paraxial approximations. We discuss the absence of point focal distances in the tracing beyond paraxial approximation. We show by simulation the result of our discussion, and applying the knowledge to a case of camera lens.*

1 Introduction to optical ray tracing technique

Light consists of electric and electromagnetic waves traversing along a course. The direction of propagation of light can be narrowed down to beams of light, which we called rays. A beam of rays is "perpendicular to the wave fronts" (Hecht, 2002). This assumption led to the basics of the Ray Optics, or Geometrical Optics, which concerns on the ray aspects of light, where the wavelength, caused by diffraction, conceptually goes to zero, so that one would find light beams as a "rectilinear propagations obtained in homogeneous media" (Hecht, 2002). In Ray Optics, the study concerns with the Laws of light propagation such as reflection and refraction, apertures and stops, and optical systems.

One of the scientific breakthroughs in geometrical optics is the optical ray tracing technique. In designing optical instruments such as telescope, microscope, and glasses. it is necessary to determine the path of light travelling through these instruments in order to magnified, minified and correcting images. A lot of techniques can be used to calculate the destination of propagation of light. One of these techniques, optical ray tracing technique which utilizes the Law of Reflection and Refraction, is widely used in practice. This technique combines the Laws and geometry to accurately determine the position of light paths which goes through an optical system. Although one might determine the path algebraically, we will show numerically how this technique can be applied to accommodate the computing abilities of computers in today's cutting edge.

2 Optical ray tracing technique within and beyond paraxial approximation

The optical ray tracing technique is calculated using elementary geometry. We already made the assumption that light is considered as ray for the ray tracing technique using elementary geometry to be possible. We will deal with two kinds of rays tracing for rays travelling in the meridional axis, which are oblique ray and parallel ray.

2.1 Optical ray tracing technique in paraxial approximation

2.1.1 Paraxial Approximation