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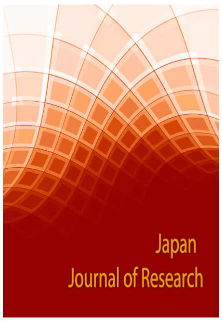

Ellipsoid Lens that Makes up the Telescopic Eye Lens

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Abstract

In this article we propose an elliptical structure with elliptical coordinates and a variable point radius, for each eye lens that makes up the telescopic eye lens. In which the telescopic eye lens are proposed for the aid of age macular degeneration (AMD), eye disease that causes the loss of central vision that explained in article.

The reason for the varying point radius in each lens is so that each eye will have clear vision from near and far, central vision and peripheral vision.

Introduction

In the article [1] we presented cylindrical and spherical coordinates, and in articles [2,3] we presented mirror eye lens and telescopic eye lens consisting of 3 lenses with a variable point radius eye lens for the aid of age macular degeneration (AMD) but we did not present the structure of the lens. The mirror lens is impractical because light is required in the spring that does not exist.

In this article, we propose an elliptical structure with elliptic coordinates with a variable point radius, for each lens that makes up the telescopic lens.

Developments for determining variable point radii and the location of minimum and maximum radii in the elliptical lens with elliptical coordinates according to Figure 1

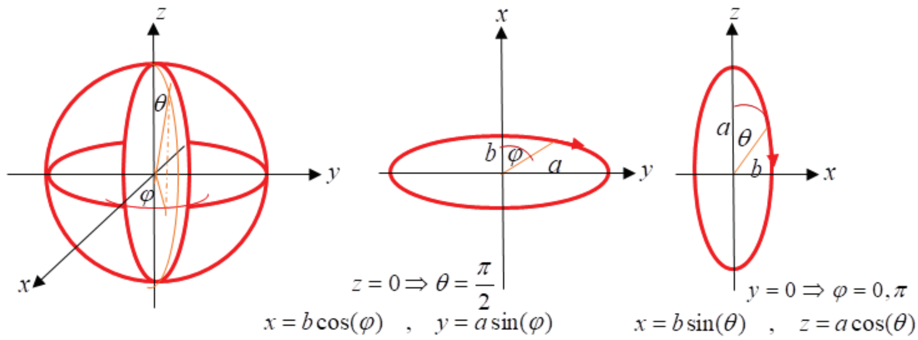

Figure 1. *Elliptical coordinates*

$$\frac{x^2}{b^2}+\frac{y^2}{a^2}+\frac{z^2}{a^2}=1, \quad x=b\sin(\theta)\cos(\varphi), \quad y=a\sin(\theta)\sin(\varphi), \quad z=a\cos(\theta), \quad a>>b>0$$

$$\textbf{Where}: z=0 \Rightarrow \theta=\frac{\pi}{2} \Rightarrow x=b\cos(\varphi), \quad y=a\sin(\varphi)$$

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According to appendix A where f is the eye lens focus:

$$x'(\varphi) = -b\sin(\varphi) \Rightarrow x''(\varphi) = -b\cos(\varphi) \quad , \quad y'(\varphi) = a\cdot\cos(\varphi) \Rightarrow y''(\varphi) = -a\cdot\sin(\varphi)$$

$$r(\varphi) = \frac{\sqrt{((x'_\varphi)^2 + (y'_\varphi)^2)^3}}{\left|y''_{\varphi\varphi}x'_\varphi - x''_{\varphi\varphi}y'_\varphi\right|} = \frac{\sqrt{(b^2\sin^2(\varphi) + a^2\cos^2(\varphi))^3}}{ab\cdot\sin^2(\varphi) + ab\cdot\cos^2(\varphi)} = \frac{\sqrt{(b^2\sin^2(\varphi) + a^2\cos^2(\varphi))^3}}{ab}$$

$$r(\varphi)\max = r(0) = \frac{a^2}{b} \Rightarrow f\min, \quad r(\varphi)\min = r\left(\frac{\pi}{2}\right) = \frac{b^2}{a} \Rightarrow f\max, \quad a^2 > b\,, b^2 < a$$

Mathematical proof:

$$r'(\varphi) = \left(\frac{\sqrt{(b^2\sin^2(\varphi) + a^2\cos^2(\varphi))^3}}{ab}\right)' = \frac{3\sqrt{b^2\sin^2(\varphi) + a^2\cos^2(\varphi)}}{2ab}(b^2 - a^2)\sin(2\varphi) = 0$$

$$\sin(2\varphi) = 0 \Rightarrow \varphi = 0\,, \varphi = \frac{\pi}{2} \quad , \quad r''(\varphi)_{\varphi=0} = \frac{3}{4b}(b^2 - a^2) < 0 \Rightarrow r(\varphi)\max = r(0) = \frac{a^2}{b}$$

$$r''(\varphi)_{\varphi=\frac{\pi}{2}} = \frac{-3}{4a}(b^2 - a^2) > 0 \Rightarrow r(\varphi)\min = r\left(\frac{\pi}{2}\right) = \frac{b^2}{a}$$

Where : $y = 0 \Rightarrow \varphi = 0, \quad \pi \Rightarrow x = b\sin(\theta), \quad z = a\cos(\theta)$

According to appendix B where f is the eye lens focus:

$$x'(\theta) = b\cos(\theta) \Rightarrow x''(\theta) = -b\sin(\theta) \quad , \quad z'(\varphi) = -a\cdot\sin(\theta) \Rightarrow z''(\theta) = -a\cdot\cos(\theta)$$

$$r(\theta) = \frac{\sqrt{((x'_\theta)^2 + (z'_\theta)^2)^3}}{\left|z''_{\theta\theta}x'_\theta - x''_{\theta\theta}z'_\theta\right|} = \frac{\sqrt{(b^2\cos^2(\theta) + a^2\sin^2(\theta))^3}}{\left|-ab\cdot\cos^2(\theta) - ab\cdot\sin^2(\theta)\right|} = \frac{\sqrt{(b^2\cos^2(\theta) + a^2\sin^2(\theta))^3}}{ab}$$

$$r(\theta)\max = r\left(\frac{\pi}{2}\right) = \frac{a^2}{b} \Rightarrow f\max, \quad r(\theta)\min = r\left(0,\pi\right) = \frac{b^2}{a} \Rightarrow f\min, \quad a^2 > b\,, b^2 < a$$

Mathematical proof:

$$r'(\theta) = \left(\frac{\sqrt{(b^2\cos^2(\theta) + a^2\sin^2(\theta))^3}}{ab}\right)' = \frac{3\sqrt{b^2\cos^2(\theta) + a^2\sin^2(\theta)}}{2ab}(a^2 - b^2)\sin(2\theta) = 0$$

$$\sin(2\theta) = 0 \Rightarrow \theta = 0\,, \theta = \frac{\pi}{2}, \quad r''(\theta)_{\theta=0} = \frac{3}{4ab}(a^2 - b^2) > 0 \Rightarrow r(\theta)\min = r\left(0,\pi\right) = \frac{b^2}{a}$$

$$r''(\varphi)_{\varphi=\frac{\pi}{2}} = \frac{-3}{4a}(a^2 - 1) < 0 \Rightarrow r(\theta)\max = r\left(\frac{\pi}{2}\right) = \frac{a^2}{b}$$

The relationship between point radius of eye lens and focal distance in the lens f, according to figure 2.

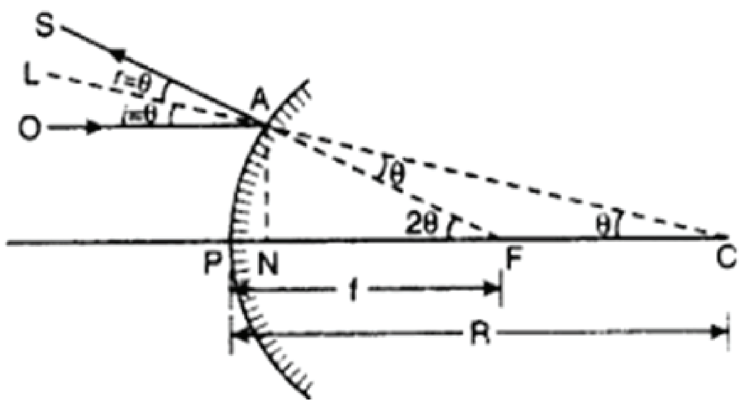

Figure 2. *Radius of eye lens and focal distance in the lens*

$$h = \lim_{\delta \to 0}(R - \delta)\cdot \tan(\theta) = \lim_{\delta \to 0}(f - \delta)\cdot \tan(2\theta)$$

$$R \cdot \tan(\theta) = f \cdot \tan(2\theta) = f\,\frac{2\sin(\theta)\cos(\theta)}{\cos^2(\theta) - \sin^2(\theta)} = f\,\frac{2\tan(\theta)}{1 - \tan^2(\theta)}$$

$$R \cdot \lim_{\theta \to 0}\tan(\theta) = R\cdot\theta = 2f\cdot \lim_{\theta \to 0}\frac{\tan(\theta)}{1-\tan^2(\theta)} = 2f\cdot\theta \Rightarrow f = \frac{R}{2} = \frac{r}{2}$$

The usefulness of a telescopic lens consisting of elliptical lenses with a variable local point radius is shown in figure 3.

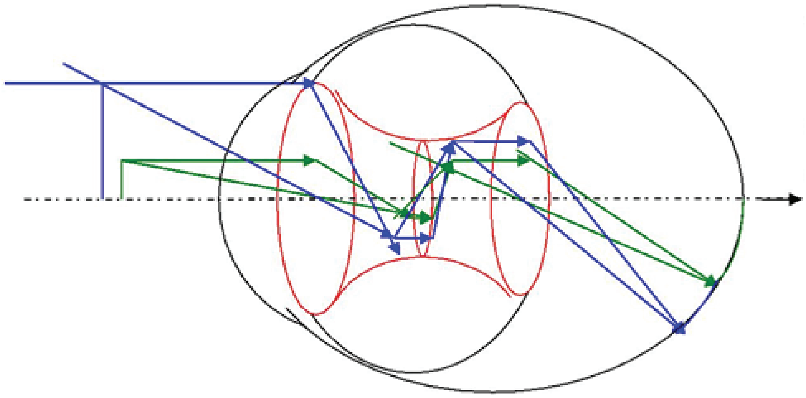

Figure 3. *The benefit of a telescopic lens consisting of elliptical lenses with a variable local point radius*

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Appendix

Appendix A (Appendix in Article [2])

A variable point radius for a line where:

$$z = 0\,,\; y = y(x), \quad r(x) = \frac{\sqrt{(1+(y'(x))^2)^3}}{|y''(x)|}$$

and where: $\vec{r}(t) = x(t)i + y(t)j$

$$y'(x) = \frac{dy}{dx} = \frac{dy}{dx}\cdot\frac{dt}{dt} = \frac{dy}{dt}\cdot\frac{dt}{dx} = \frac{y'_t}{x'_t} \Rightarrow \sqrt{(1+(y'(x))^2)^3} = \frac{\sqrt{((x'_t)^2+(y'_t)^2)^3}}{(x'_t)^3}$$

$$y''(x) = \frac{d}{dx}\left(\frac{dy}{dx}\right) = \frac{d}{dx}\left(\frac{dy}{dx}\right)\cdot\frac{dt}{dt} = \frac{d}{dt}\left(\frac{y'_t}{x'_t}\right)\cdot\frac{dt}{dx} = \frac{1}{x'_t}\frac{d}{dt}\left(\frac{y'_t}{x'_t}\right) = \frac{y''_{tt}x'_t - x''_{tt}y'_t}{(x'_t)^3}$$

$$r(x) = \frac{\sqrt{(1+(y'(x))^2)^3}}{|y''(x)|} \Rightarrow r(t) = \frac{\sqrt{((x'_t)^2+(y'_t)^2)^3}}{|y''_{tt}x'_t - x''_{tt}y'_t|} = \frac{|r'(t)|^3}{|r'(t)\times r''(t)|}$$