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Design and implementation disorganization of optical and geometric correction algorithm for Shimpflag imaging method by Pantacam for quantitative evaluation eye lens

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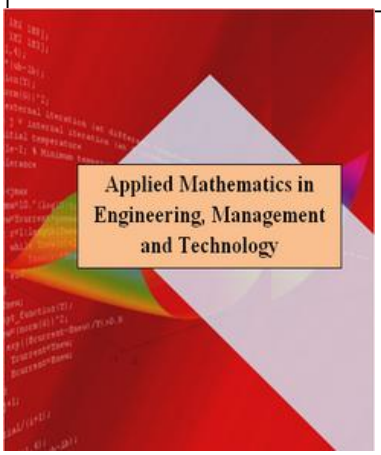


ABSTRACT

The wide variety of the eye diseases can be diagnosed by the Scheimpflug method. The method is used to take images from eye's entire meridian. However the imaging method suffers from geometrical and optical distortion which decreased the accuracy of the eye's diagnosis. The purpose of this manuscript is to develop algorithms for the optical and geometrical distortion correction of the commercial Scheimpflug camera Pentacam, Oculus. To obtain the camera nodal points, the algorithm in Matlab based on least-mean square procedure was written. Once the nodal points were obtained, the correction distortion algorithms were applied on Scheimpflug images of an artificial eye with known dimensions.
The estimated nodal points allowed obtaining the nominal radius of the eye physical model with an accuracy of 95%. The average error in the retrieved intraocular distances was of -5.5%, 2.5%, 5.7% and 20% for corneal and lens radius, respectively. A wide variety of diseases can be detected by the method Shim Flag. Shim Flag technique imaging enables all meridians of the globe provides cryptographic operations such as cutting methods Track. On the other hand, the image of the meridian retinal is disorganization optical and geometrical. However, there is disorganization reduces diagnostic accuracy of different eyes.

Keywords: geometric disorganization - disorganization - Optical correction algorithms - Shim Flag - Pantakm - nodal point - radius of curvature.

1.Problem Statement

Explanation, estimation and evaluation of the wide range of eye diseases are obtainable by precision measurement of different levels of the radius of curvature and thickness of the eye lens. So the optical aberrations of the eye lens are very important to check the possible causes of these errors. Meanwhile allowing the evaluation of the coefficients variation of the failure increases at the age ascending, and even check compliance events are available (i). In addition, measurement of corneal thickness, corneal health evaluation is one of the main factors. It plays an important role in determining of the treatment and diagnosis of eye diseases. Various methods for determining geometric properties of the cornea and lens are objective. These methods are including: UP (ii), Ultrasound microscopy (iii), confocal microscopy and Shim Flag imaging techniques.
UP method as the reference method for measuring corneal thickness is considered. Because this method between Users and different devices to be used has a very good repeatability (vi). However, at this method generated Ultrasonic waves have direct contact to the eye cornea. In some circumstances this could lead to infection in eye and cause a disease. In addition, the expert should be perpendicular to hold the probe relative to the center of the cornea. Otherwise corneal thickness is estimated to be greater. On the other hand the accuracy of this method may be affect due to hydration changes induced by Ultrasound waves (v). Shim Flag method resulting could be a non-contact method and fast to measure the coordinates of the geometric components of the radius and thickness of the cornea and lens of the eye can be used.

Shim Flag imaging (schiemp flug) is very powerful and useful technique for imaging anterior of the eye. Shim Flag system includes a camera Charged Coupled Device (CCD), which is rotated around at the central axis based on the patient's eye and simultaneous parallel beam of light glinting through a lens to the corneal surface of patient or object falling on as the page. Thus sagittal slice of eyeball is obtained. Picture screen, corneal screen and the objective lenses are angled towards each other. Finally is cleared that along the light beam makes an angle about 45 degree towards to the corneal screen.
The relationship between picture screen and corneal screen based on angle lens is about 45; hence the Shim Flag technique is permit able method to possibility of imaging from all of meridians eyeballs and acts as cutting graphic techniques. In Flag moving images, introducing of disorganization and geometrical optics on the corneal structure and lens (Distortion) is not unlikely. Therefore Imaging System software is capable to correcting of related errors of corneal disorganization. Thus accurate calculation of the radius of the anterior and posterior cornea is obtainable. Whereas lens imaging behind the corneal and system will not able to correct the disorganization.
The main objective of this research is writing and performing optical and geometrical disorganization correction algorithms of the Pantakm device by Shim Flag imaging method.

2.Materials and Methods

The physical model of the eye to produce raw data is an attempting to implement image processing methods. After processing techniques, geometrical coordinates are obtainable by imaging system. Disorganization of the lens by tracing method to calculate the radius of the anterior and posterior lens is corrected finally.
Physical model of the eye was made based on cardinal points Strand Flower Model. In this model, instead of the cornea hard lens (PMMA 9) with a curvature radius of 7.6 mm and Shay anterior posterior curvature of 5.56 mm and a thickness of 0.5 mm was used.

Instead of intraocular lens the sophisticated material lens (PMMA) (lenses manufactured under license visit Kiel (kiels) from Germany) with 9.61 mm radius of curvature of the anterior surface and the posterior surface curvature Shay 6 mm and a thickness of 1.17 mm was used.
Then these physical model lenses periodically were scored according to the Strand model. Therefore, the dark chamber with dimensions of 90 mm to 50 mm in 40 mm from plastic-glass with Cartesian coordinate geometry was designed and built for lenses storage and preparing.
The physical model of the eye was prepared by Pantakm device and image processing algorithms on the next steps were performed. In order to perform image correction algorithm on the imaging system will attempt to calculate the geometric coordinates, so that the coordinates computed by the algorithm was run. After determining the coordinates of the imaging system, the algorithm was applied to the case written by Shim Flag. After applying the correction algorithm, correcting curvature of the anterior corneal surface was obtained. After obtaining this level, the algorithm level using the fitted circle and its radius of curvature was calculated. Finally the algorithm is applied to the correction of optical errors of the posterior surface of the cornea, the anterior surface of the lens and the posterior surface of the lens, respectively. Finally, the curvature radius of curvature radius obtained by physical model eye was compared by statistical evaluation. Processing algorithms can include filter applied (canny) for separation of the eye (anterior surface of the cornea) of the other levels and improving contrast. Therefore, the filter was written and performed in the MATLAB environment. The implementation process includes applying the filter, Gaussian filter, image acquisition Gradient, and thresholding is thin.

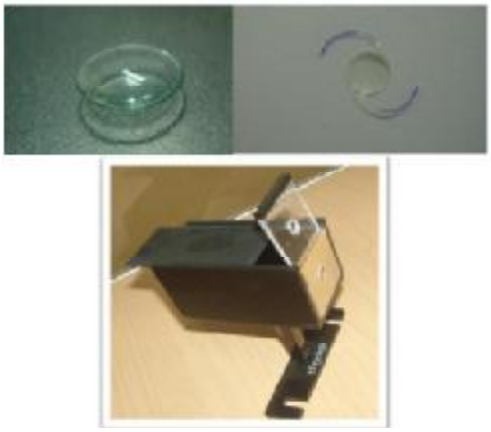


Figure 1 - Hard Intraocular Lenses used in the physical model of the eye

After pre-processing step to separate the anterior surface of the cornea and other surfaces were attempted. It is noteworthy that the anterior surface of the cornea lacks optical disorganization. Therefore, for each level of a matrix of the appropriate size (size of the original picture) was prepared containing the pixel coordinates and the edges were determined. So that the next edge along the y -coordinate of each edge is a marked difference. So the bottom edge of the profile obtained by adding the difference between the anterior edges of the coordinate obtained. Thus, the coordinates of all points on an edge-to -edge anterior surface of the cornea are separated from other wastes.
Draw a line on the page using the object coordinates are determined. So that line is drawn
Its origin is the point of the image plane. This line passes through the nodal point to the Page object in the cut a given transfer function theorem, we get the coordinates of the object to the image plane defines Flag. So the algorithm in MATLAB to obtain the moving object based on the story was written and performed Flag. After the transfer to the object, the method throws (Pratt) was used for curve fitting.

Due to the rotational symmetry of the cornea, corneal posterior surface of the spatial coordinates of the location coordinates of the anterior surface of the cornea
And line drawings, respectively. Therefore, the optical line image along the nodal points was drawn to the Page object. The line after hitting the anterior surface of the cornea and corneal thickness and went broke. Beam passing through the posterior surface of the cornea to determine location coordinates. Get the location coordinates of the posterior surface of the cornea, Korean radius to fit the parts were made. The results of calculating the geometric coordinates of the imaging system
Geometric coordinate system for moving imaging Flag Pantakm is not provided by the manufacturer. Thus rules-based algorithm was written and performed geometry. Implementation of the algorithm based on the method used to draw lines, respectively. From page to page so that the objective lens (a), distance from the lens to the screen image (b), and β the angle between the lens and the image plane. So a = 28 mm, b = 74 and b as 29 degrees respectively. The values range from 59 to 2 mm device.

3. Imaging results from the physical model of the eye

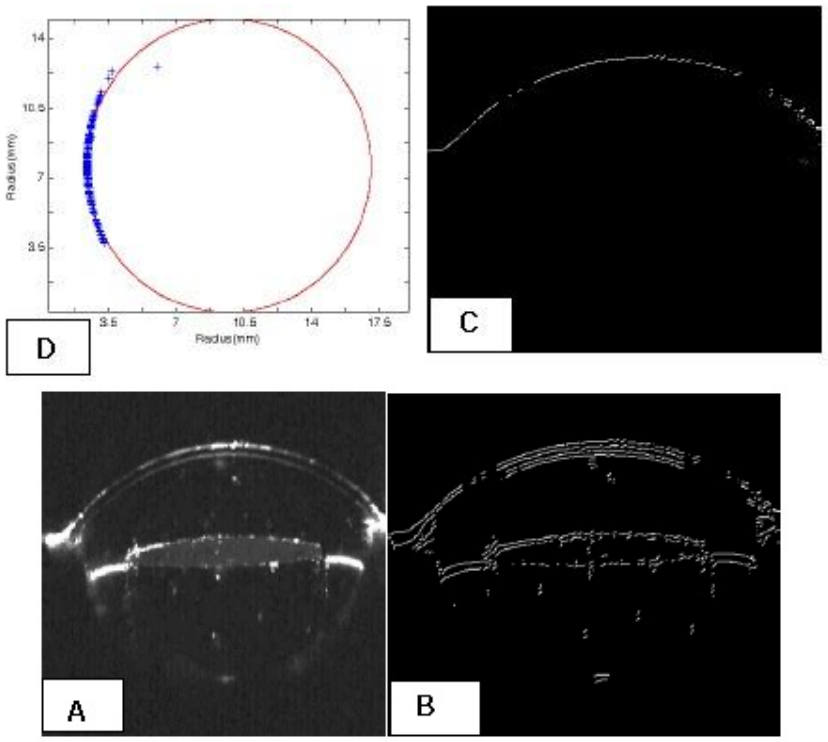


Figure 2: A - Shim Image Flag prepared from a physical model of the eye
B - Shim Photos Flag After processing method
C - Edge of the anterior surface of the cornea is isolated from other levels
D - Location coordinates of the circle fitted to the anterior surface of the cornea using an algorithm Perth

Table 1 - Coordinate the results of the eye before and after applying the correction algorithm disorganization

Correction method	hysical model of eye	
The amount of Radius surface	before correction	after correction
The radius of the anterior corneal surface (mm)	8.58 ± 0.03	7.2 ± 0.03
The radius of the posterior corneal surface (mm)	7.87 ± 0.03	5.83 ± 0.03
The radius of the anterior surface of the lens (mm)	12.23 ± 0.05	10.2 ± 0.05
The radius of the posterior surface of the lens (mm)	9 ± 0.03	7.5 ± 0.03

4.Discussion

In the general case of eye models designed with a natural look inconsistent. But glass used in building the model is close to the radius of curvature of the cornea and lens of the eye and the light scattering them further. But the overall quality of the physical model eye Flag're worse than a normal eye images
's. So that the model of the eye, especially the anterior and posterior surfaces of the lens are clearly appropriate. Light as it passes through the different parts of a physical model of the eye are scattered less than the normal

eye. The anterior and posterior surfaces of the lens moving image Flag made from normal eyes are clearly visible. Because the radiation reaching the surface of the lens protein and other vital nutrients back into the lens and the CCD camera are scattered. The light intensity distribution of the optical radiation angle lens depends on the protein concentration (Vi).
So, due to the low quality of the physical model of the eye, and lack of access to raw data processing algorithm suitable physical model eye for images written in MATLAB and implemented. The algorithm consists of two phases: the pre-processing and post-processing. Preprocessing step high-pass filter was used to improve contrast. The method of postprocessing filters to separate you came to the edge of the eye surface. This algorithm is applied so as to include Gaussian filter along x and y, the gradient of image acquisition, the thresholding and morphology.

5.Conclusions

The software project based on line drawings methods to correct the disorganization imaging system was designed by Shim Flag Pantakm in MATLAB environment. This algorithm is able to measure the radius of curvature of the physical model eye. The results show that after applying the correction algorithm of curvature difference of 5.65% is obtained with the reference value. This means that the estimated level of the anterior and posterior lens radius of 0.4 mm and 0.3 mm, respectively, there is an error. The results show that the values obtained after applying the correction algorithm disorganization is closer to the actual values.

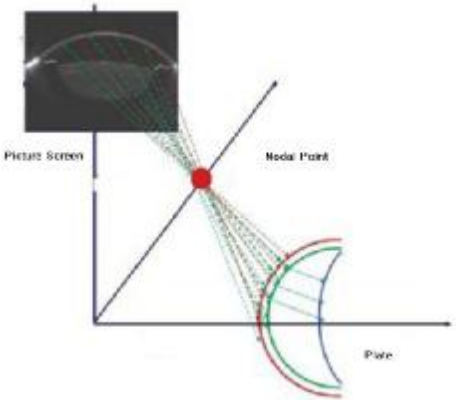


Figure 3 - Draw lines to get the original coordinates of the imaging system

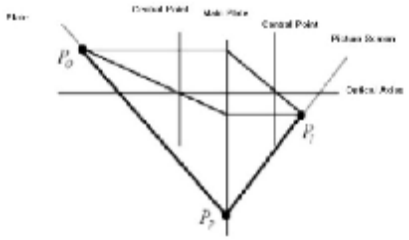
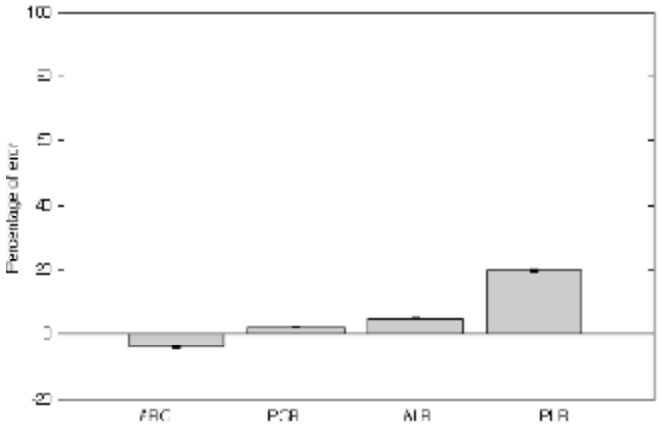


Figure 4 - Status screen and the screen geometric objects with respect to Case Shim Flag



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