Corneal Topography by Specular Reflection: a Low-Cost Null-Hartmann Screen Test

Martín Isaias Rodríguez-Rodríguez[1,2], Oscar Ramos[2], Alessandra Carmichael Martins[1] and Brian Vohnsen[1]

[1] Advanced Optical Imaging Group, School of Physics, University College Dublin, Ireland

[2] Carrera de Optometría FES Iztacala-UNAM, Avenida de los barrios No. 1 los Reyes Iztacala, Tlanepantla, Edo. de México C.P 54090

The aim of this study is to validate a rapidly reconfigurable null-test using a Hartmann pattern as target. The image of reflected light from a spherical reference sphere is used to test the capability of the corneal surface characterization method. A integration method is used to derive the shape of the reflective surface using a reflective spherical reference surface as a corneal simulator. Reconstruction using the trapezoid rule offers an easy solution as is shown in refs [1-3]. Measurements are performed on 4 healthy subjects' eyes.

Introduction

The anterior corneal surface provides about 80% of the total dioptric power of the human eye. Traditionally, corneal topography has been studied by commercial Topographers who mostly rely on the Plácido disc. A possible limitation of this system is the ambiguity of data in azimuthal direction. For that reason, recently it has been developed new generations of Topographers that use a different principle.

Objectives

According to the theory developed with the null screen method [1-3], an experimental setup based on the null-test using Hartmann pattern is proposed, which, allow us to evaluate the corneal surface guaranteeing a good efficiency and sufficient resolution in the optical parameters required.

Methodology

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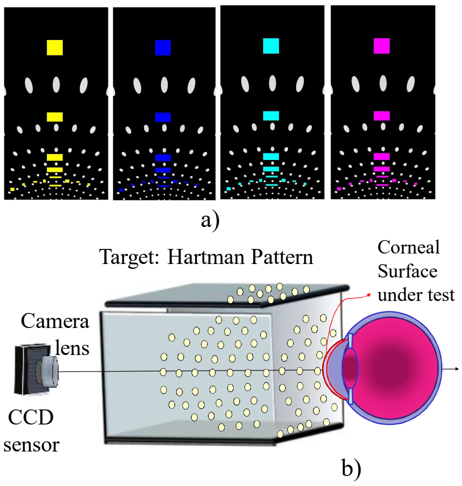

Fig. 1. a) Patterns of Hartmann [2], b) Schematic setup of Corneal Topographer.

Experimental setup

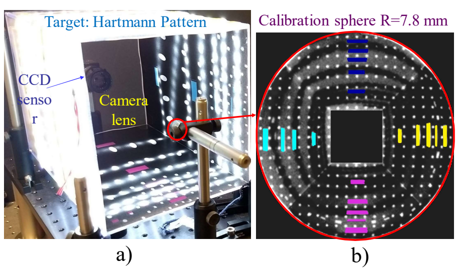

Fig. 2: a) Experimental setup, b) glass sphere ball under test representing the corneal surface.

Imaging Processing

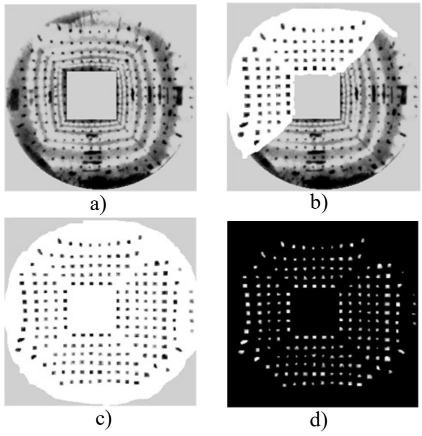

Fig. 3. Imaging Processing: a) Best Contrast, b) first segmented image, c) Final segmented imaging, d) Thresholding imaging.

Experimental results

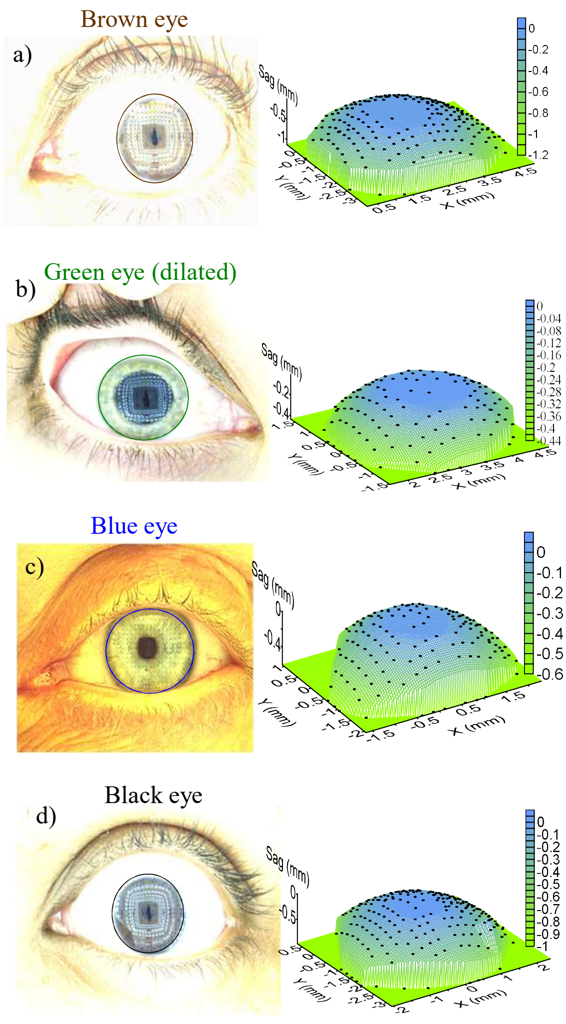

Fig. 4. Measurements of shape corneal surfaces performed on 4 healthy subjects' eyes: a) ○ Subject 1, b) ○ Subject 2, c) ○ Subject 3, d) ○ Subject 4.

Topography Maps of a glass sphere ball

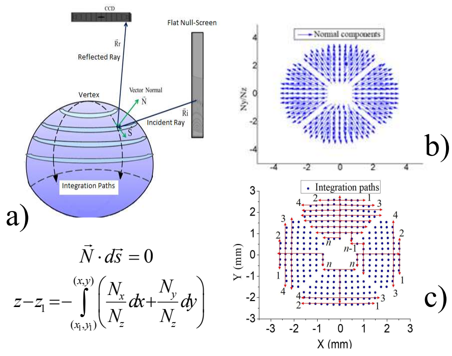

Fig. 5. Integration method by deflectometry technique [1, 2].

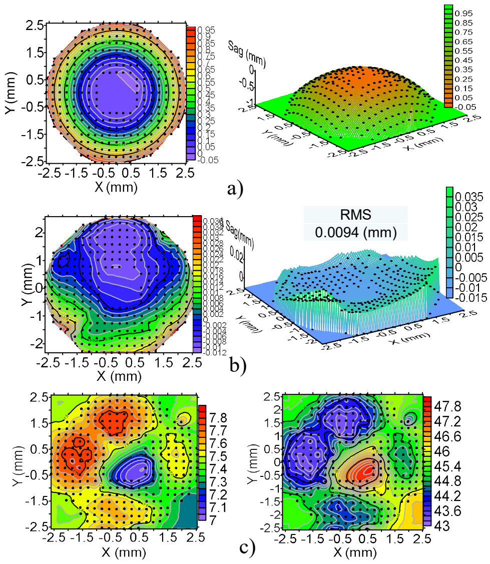

Fig. 6. Results of calibration sphere: a) Shape of the surface, b) Elevation Maps by Sagitta Differences, c) Curvature Radii and Dioptric Power [3].

Conclusions

The quantification of the corneal surface is of great importance in clinical and research applications of relevance for refractive corrections and the diagnosis and monitoring of corneal ectasias and keratoconus.

A rapidly reconfigurable and low-cost system with reconfigurable parameters as demonstrated here may suffice for corneal reconstruction.

References

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Contact: martin.isaias.rodriguez@gmail.com

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