Chapter 16
Recent Advances in Corneal Imaging

Abdulhakim Elbita
Bradford University, UK

Rami Qahwaji
Bradford University, UK

Stanley Ipson
Bradford University, UK

Taha Y. Ahmed
Bradford University, UK

K. Ramaesh
Bradford University, UK

T. Colak
Bradford University, UK

ABSTRACT

The cornea is the convex and transparent covering in the front of the eye. It is responsible for most of the focusing power required to create an image on the retina. Injuries and various pathologies such as (keratoconus, lattice dystrophy, dry eye, conjunctivitis, etc.) of the cornea compromises vision. Due to loss of corneal transparency, hence scattering light rays passing through the cornea, in severe cases, total sight loss can occur.

A confocal microscope can be used to provide a sequence of images (of variable quality) at different depths from the front surface of the eye, showing the various corneal layers and structures. From these images, Ophthalmologists can extract clinical information on the state of health of a patient’s cornea. Currently, analyses of these images are mainly based on visual interpretation of these images or on semi-automatic methods, which might contribute to making erroneous diagnoses.

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This chapter details work with sequences of corneal images from a confocal microscope to develop enhancement methods to improve the visual quality of the images. Due to involuntary movements of the subject's eye during image capture, the images suffer both lateral and longitudinal translations, and work is ongoing to attempt to register adjacent images in the sequence. Currently this registration uses an approach based on the Scale Invariant Feature Transforms (SIFT) algorithm. Registration is a necessary stage in the construction of a 3D model of the subject's cornea for use as a diagnostic aid. The algorithms, results, progress and suggestions for future work are presented in this chapter.

**INTRODUCTION**

**The Structure of the Cornea**

The cornea is a collection of cells and proteins that constitute a very highly organized structure. It is the clear outer layer, covering the front of the eye. The cornea must remain transparent to transmit and refract light. The cornea does not contain blood vessels to feed or protect it from infection, however it receives its nourishment from tears and the aqueous humour (fluid filling the Anterior chamber which is the space between the lens and cornea). Figure 1 shows the anatomy of the eye, and inspecting it we can recognize that the anterior surface of the cornea, which is not uniformly curved (H.E. Kaufman 2000; MedicineNet 2010).

The dimensions of the cornea are, on average, 12.6 mm in the horizontal direction median and 11.7 mm in the vertical median. Its thickness is not uniform, with the central cornea thinner than the peripheral cornea (520 µm =< thickness <= 650 µm) (H.E.Kaufman 2000). The cornea has a tear film on its front surface and three main layers separated by two thin membranes. The Epithelial layer is the outermost layer of the cornea and is separated by the Bowman’s membrane from the central Stroma layer, which in turn is separated by the Descemet’s membrane from the innermost Endothelium layer as shown in Figure 2. Approximate thicknesses of these layers in the

*Figure 1. The anatomy of the Eye (MedicineNet 2010)*
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