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Medical Background

- Over 5% of Americans aged 50+ suffer from moderate to severe dry eyes
- Symptoms: itchiness, discomfort and damage to the corneal surface
- It is the most common complication of contact lens wearers
- Fluorescein Break Up Time (FBUT) is the test most commonly used by clinicians
- Break Up Time (BUT): time passed after a blink until dry areas appear
- The location, shape, progression and depth of the break determine what treatment to choose
- This is not possible with current clinical routines or any automated method
- The EyeScan system videos the front of the eye



Image after a blink



Image before the next blink

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Automatic Dry Eye Detection

Tamir Yedidya¹, Richard Hartley¹, Jean-Pierre Guillon², Yogesan Kanagasingam² ¹ The Australian National University and National ICT Australia ² The University of Western Australia, Faculty of Medicine, Dentistry and Health Sciences, Lions Eye Institute

Algorithm

The images of interest are those between two consecutive blinks, defined as a sequence. Based on 3 main steps:

- Detection of the iris in each frame
- Alignment of the images
- Finding the dry areas and the BUT

> Fitting a circular model

 Detect the eyelids using RANSAC Remove all pixels below and above the eyelids

• Detect the iris with RANSAC using a circle model with 3 parameters (x,y,r) Refine the location using Levenberg-Marquardt (LM)

• Find the iris in the rest of the images in the sequence using LM and the Huber distance



LM middle frame (182,110,116)

Computing Image Alignment



an aligned video

examined

- A confidence map of the thinning of the tear film over the corneal area is built
- The BUT is defined as the time when a pixel has no further decrease in intensity

- The alignment is necessary since the camera is hand held and the iris moves • In the aligned video the iris will appear in the same location and size
- •Based on minimizing differences in intensities in an area surrounding the iris:

C(H) = $\sum (I_x^{(j)} - I_{Hx}^{(k)})^2$ x∈ROI



Averaged images of a non-aligned video and

- Segmentation of the dry area
- The change in intensity of each pixel is

Results

- no visible dryness
- of a clinician
- In terms of area segmented, we had 91% accuracy ranging from 84% to 96%



The brighter the area the drier it is



• We captured over **100 videos** of more than **30 different** patients (Sep 2007) varying from having a very dry eye to

Our results were compared with hand segmented results

