MASTER IN PHOTONICS – PHOTONICS BCN
EUROPHOTONICS-POESII MASTER COURSE

PROPOSAL FOR A MASTER THESIS

Dates: 2020

Laboratory: Center for Sensors, Instruments and Systems Development (CD6)
Institution: Universitat Politècnica de Catalunya
City, Country: Terrassa

Title of the master thesis: Image processing of a system to measure the tear film stability.
Name of the master thesis supervisors:
Jaume Pujol jaume.pujol@upc.edu
Mikel Aldaba Arévalo mikel.aldaba@upc.edu

Summary of the subject:

The tear film is the first surface of the eye which is in contact with the air. When its normal function is altered dry eye appears, a multifactorial disease of the tears and ocular surface that results in symptoms of discomfort, visual disturbance, and tear film instability with potential damage to the ocular surface. Dry-eye has high prevalence, up to 30%, and which is expected to increase due to the use of contact lenses, LASIK and all sorts of displays.

There are several tests in clinical practice for dry eye diagnosis. Despite the wide use of those techniques in clinical practice, there is general agreement of their limitations as being subjective and invasive. In this sense in the last years a big effort has been made to develop objective and non-invasive methods for dry eye diagnosis based in new technologies. However, up to date no gold-standard exists for the diagnosis of dry eye, and some of the methods based in new technologies are unfeasible in clinical environment as cannot be adopted to daily clinical practice, where inexpensive and easy-to use tools are needed.

In the last years our research group has propposed a new method for tear film evaluation by means of corneal reflex image degradation analysis, a simple technique based on photonics. When the tear film is in good condition the image of coherent light reflected on the cornea, is regular and of good quality. However, when the tear film breaks up, the corneal reflex degrades. By means of the corneal reflex image degradation, our method evaluates the tear film and could be used on dry eye diagnosis. Up to date, our research group has done basic research on the field, developed the method, built a pre-prototype and carried out measurements in laboratory and clinical conditions. Fruits of this labor, we have done international communications of the scientific progresses, published a paper on an international journal and patented the method. However, the technique presents a main limitation on the mesured area.

Up to date, the corneal reflex image degradation is done based on the image fragmentation. To do this, the images are binarized and the number of structures in which it is fragmentated counted. The number of structures is plotted with time and a curve fitted. The break up of the tear film is determined as the elbow of the fitted curve, when the number of images suddenly increases due to the tear film worsening.
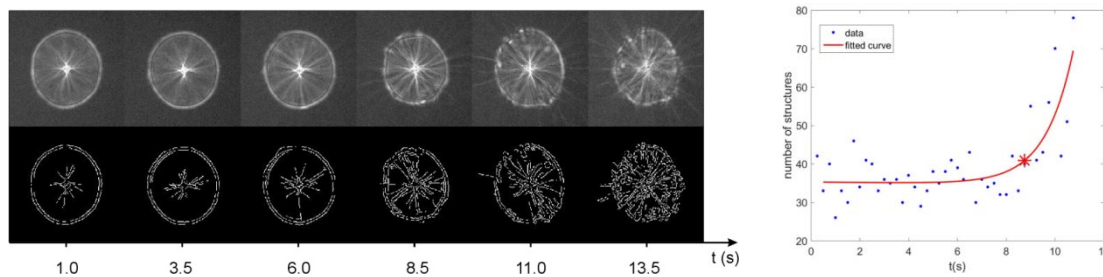

Fig. 1. Left, corneal reflex image sequence after blinking. Raw (upper) and binarized (lower) images are shown. t(s): time in seconds after blinking. Right, number of structures counted plotted against time after blinking. Experimental data is plotted with blue dots, the fitted curve in red, and the break up time with a red asterisk.

Your master thesis project will consist of the proposal of a new image processing method to detect the break up of the tear film from the already registered image database.

Keywords: tear film, dry eye, image processing, biomedical photonics.

Additional information :

* Required skills: Self-motivated, objective-driven, capable of autonomous working within a multidisciplinary team.