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A DATA ACQUISITION, PROCESSING AND STORAGE SYSTEM FOR AN OPHTHALMIC INSTRUMENT: FOTOBIOFTAL-1

S. Miclos, M. Mustata, D. Savastru, C. Cotirlan, T. Brezeanu, E. Ristici*, A. Stefanescu-Dima

National Institute of R&D for Optoelectronics, 1 Atomistilor St., P. O. Box MG 5, 77125, Bucharest-Magurele, Romania
[a]Bucharest Clinical Eye Hospital

Fotobioftal-1 system is an noninvasive instrument containing an optical stereomicroscope and a data acquisition, processing and storage system. Using EPCO 2000 software, the obtained information leads to optimal treatments for different diseases in the ophthalmological therapies. In this paper we show and discuss data acquisition on eye crystalline lens.

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1. Introduction

If the aspect of the crystalline lens may be put into evidence by a noninvasive optical device, then the obtained results lead to the possibility for opening the necessary investigations and therapies [1,2,3] using a correct technique that can prevent the developing of the diseases (opacity).

One of the medical therapies is based on laser [4]. It is a surgical operation that can be done both in clinics and ambulatory.

Fotobioftal-1 is a noninvasive instrument based on a stereomicroscope combined with a data acquisition, processing and storage system (containing a CCD camera and a PC). The real time images allow knowing the grade of evolution of the disease and regarding of it, the ophthalmologist may get a real conclusion on the therapy which must be used.

2. Experimental set-up

The experimental set–up is an useful combination between a stereomicroscope and an image acquisition photo system.

The data acquisition, processing and storage system allows to get real time images and these images may be used during a long period of observation of the patients. The device comprises a digital photo camera attached by an adapter to a stereomicroscope in a lateral region, a PC or a note-book having an USB interface and also the software. A schematic of the medical process is presented in Fig. 1.

The operating mode of the data system consists in getting the images from the visual plane in order to transmit them through the adapter to the digital CCD camera that will transmit the image to PC or note-book through the USB interface.

Special software will process all these images and then these data and images will be stored in a data base. The optical scheme of the Fotobioftal -1 is presented in Fig. 2.

* Corresponding author: esofina@inoe.inoe.ro

From optical scheme, we can see a cube beam splitter that transmits the image both to the microscope eyepiece and also to the photo camera placed at 90^0 regarding to the eyepiece's axis. The cube beam splitter transmits the optical image at 0^0 and 90^0 as 50% / 50% intensity percent.

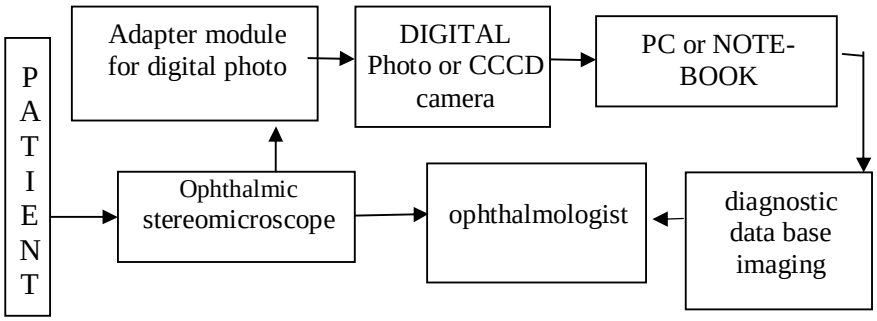

Fig. 1. Optical scheme of the data acquisition, processing and storage system for Fotobioftal-1.

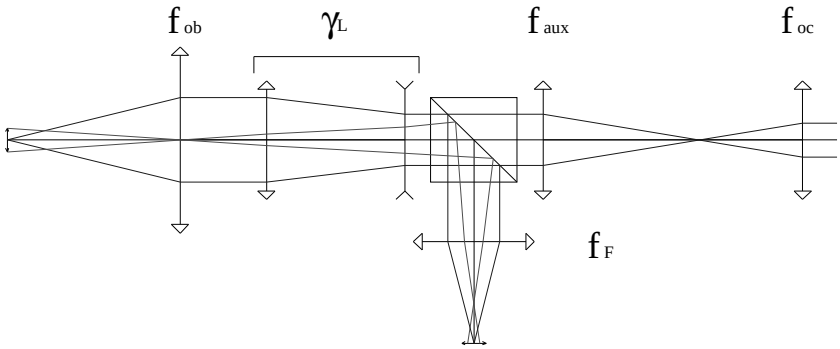

Fig. 2. Optical scheme of the Fotobioftal -1.

Where:

- f_{ob} – microscope objective, f_{ob} = 98.54 mm
- γ_L – small telescope placed on a rotating piece in order to obtain the global magnification in five steps: 5x, 9x, 16x, 29x şi 50x.
- f_{aux} – condensor objective, f_{aux} = 128.7 mm
- f_{oc} – microscope ocular, f_{oc} = 20.113 mm
- f_F –digital photo objective, f_F = 7.6 mm to 61 mm,

The adapter system consists on two components:

- beam splitting device
- mechanical tube adapter

The beam splitting device consists on two cube beam splitter (corresponding to the two ways of the binocular. They are placed between the binocular and the central part of the stereomicroscope (Fig. 3). Also, the digital photo camera can be attached either at the right or at the left side of the device.

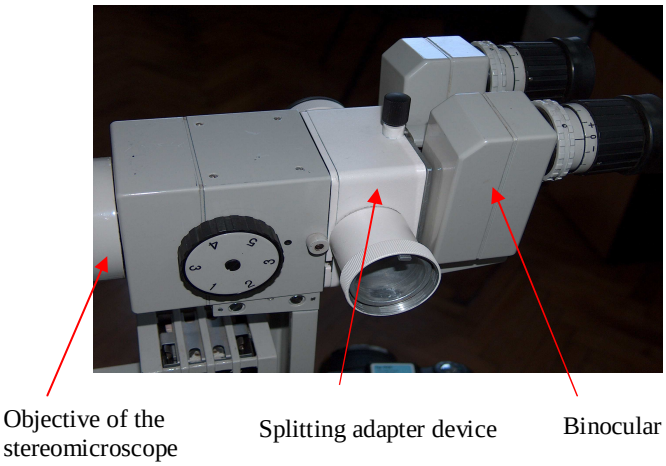

Fig. 3. The splitting device connected to the Fotobioftal-1.

The Fig. 3 shows the connecting mode of the splitting device to the Fotobioftal -1. The tube adapter represents the interface between the splitting cubes and the digital photo camera.

The collimated optical beam come out from the stereomicroscope perpendicularly and arrives to digital photo camera objective that is adjusted for infinity (Fig. 4).

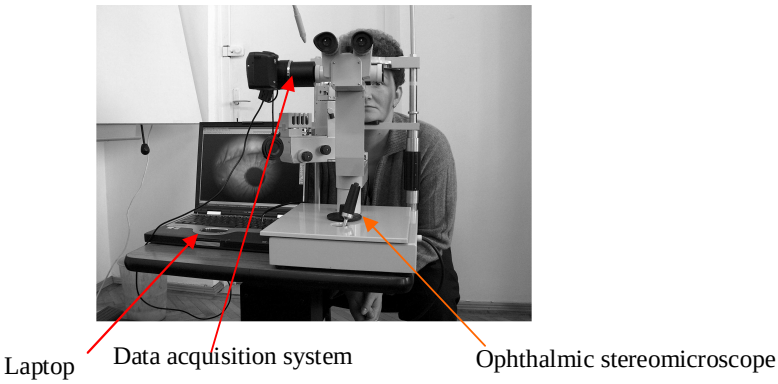

Fig. 4. Fotobioftal-1.

Fig. 4 shows the Fotobioftal-1 consisting of the stereomicroscope, the splitting device, the digital photo camera, and the computer.

3. Results and discussions

Image field η_F of the digital photo is calculated function on data of the producer. From these data, the objective focus is between 7.6 and 61 mm. The CCD is normal (24×36 mm) for the focal lengths between 37 mm and 300 mm. So, the resulted dimensions (vertical and horizontal) of the CCD sensor can be calculated and their values are given by Ec.1 and 2.

For a scale factor k= 0.2044, the vertical and horizontal dimension are:

$$V = 0.2044 \times 24 \text{ mm} = 4.9056 \text{ mm} \quad (1)$$

$$H = 0.2044 \cdot 36 \text{ mm} = 7.3584 \text{ mm} \quad (2)$$

So, the resulted η_F will be 4.9056 mm, value imposed by the minimum dimension (vertical) that limits the field.

The microscope objective (transforms the object field η_o into an angle field (Ec.3):

$$w_1 = \frac{\eta_o}{f_{ob}} \tag{3}$$

The small telescope (γ_L) changes the field w_1 in the field w_2 (Ec. 4):

$$w_2 = \frac{\eta_o}{f_{ob}} \cdot \gamma_L \tag{4}$$

The small telescope of the adapter changes the field w_2 into field w_3 (Ec.5):

$$w_3 = \frac{\eta_o}{f_{ob}} \cdot \gamma_L \tag{5}$$

Finally, the image field η_F of the digital photo will be given by Ec. 6:

$$\eta_F = \frac{\eta_o}{f_{ob}} \cdot \gamma_L \cdot f_F \tag{6}$$

So, the f_F can be calculated from Ec. 7:

$$f_F = \frac{\eta_F \cdot f_{ob}}{\eta_o \cdot \gamma_L} \tag{7}$$

In order to obtain all field of the microscope on the CCD sensor of the digital photo, Table 1 gives all the neccesary values.

Table 1.

Step	1	2	3	4	5
η_0	33	20	11.2	6.5	3.5
η_F	4.9056	4.9056	4.9056	4.9056	4.9056
f_{ob}	98.54	98.54	98.54	98.54	98.54
f_{oc}	20.113	20.113	20.113	20.113	20.113
f_{aux}	128.7	128.7	128.7	128.7	128.7
Γ	5.2	9.1	16.0	28.1	49.6
γ_L	0.323	0.569	1.000	1.758	3.100
f_F	45.4	42.5	43.2	42.3	44.6

In this case we can observe that the obtained values of the f_F are in 41 – 46 mm range for all five magnification steps of microscope

The data processing system uses the software EPCO 2000. This software is used to determine the opacity of the posterior capsule (OPC) using the morphological evaluation. The opacity of the posterior capsule is an ordinary complication of the post surgical effect of the crystalline implantation (Fig. 5).

Using the pencil/mouse and the color regions the image can be more clearly specified by colors (Fig. 6).

Making some calculations we get the opacity index of the posterior capsule and the ophthalmist may decide the necessary therapeutical method.

The splitting device enables the following facilities: scaning of the crystalline lens; this means the identification of the different regions properties (more or less shined) by colors which are

displayed on the screen of the PC; these means the information of the different parts of the tissue; recording of the different regions of the crystalline lens; obtaining of a data base for the patients;

Fig. 5. The region of opacity of the posterior capsule.

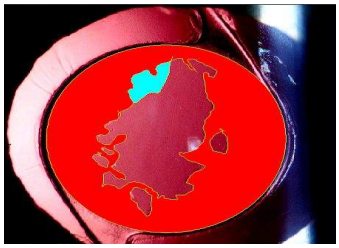

Fig. 6. Imagining by colors of the region of opacity of a posterior capsule.

4. Conclusions

The accuracy of the OPC evaluation is very important in order to get more information on the farmaceutic treatment of the deseases or different surgical types.

Also EPCO 2000 software is good to determine the influence of the used implant types and another factors in developing of the posterior capsule.

Using such an instrument every ophthalmologist may follow the evolution of the deseases or some developments after some surgical procedures in cases such as; posterior capsulotomy, iridotomy, etc.

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