Article ECORFAN Journal
OPTICAL June 2015 Vol.2 No.2 101-108

Portable system for capturing images of the sclera

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Received January 8, 2014; Accepted June 12, 2015

Abstract

For many years in México and the world there is the tendency to improve the health of people, with emphasis on prevention and early detection, one of the most common examples is detection of breast cancer, if it is detected early it is curable. This paper proposes a system for digital image capturing, principally for the detection of the sclera (the white part of the eye), because not are databases available for sclera analysis, only for iris or pupil. The device must be of moderate cost and small size to perform a self-examination in a habitual place for people, can be their home, and were used recycled and low cost materials. It should be noted that the main purpose it is to capture images as uniform as possible, and thereby in the subsequent works, the detection of the sclera is less complicated.

Diagnosis, eye, image, sclera

Citation: ROJAS, Carlos, ROJAS, Rafael, BAUTISTA, Jorge y TRUJILLO, Valentín. Portable system for capturing images of the sclera. ECORFAN Journal-Bolivia 2015, 2-2: 101-108

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Introduction

There is a significant amount of systemic diseases, ie affecting various organs of the body, as one of the first symptoms an affectation, color change or deformity of the eyes, primarily in its outer layers, such as the cornea and / or sclera (College of Medicine at Chicago, University of Illinois, 2015) (Zarranz Ventura, De Nova, & Moreno-Montañés, 2008).

Among the most important in terms of number of people with symptoms are: Diabetes mellitus, hepatitis (yellow skin and sclera), hyperbilirubinemia (yellow skin and sclera), osteogenesis imperfecta (blue sclera), acquired immunodeficiency syndrome (AIDS), Arthritis rheumatoid, hypertension and multiple sclerosis.

According to data from the National Health Information System (Ministry of Health of the State of Morelos, 2015) (National Health Information System, 2015), in Mexico more than 75 thousand people die from diabetes mellitus and complications, more than 28,000 from liver disease, more than 15 thousand hypertensive diseases, as well as nearly 5000 HIV / AIDS.

So a periodic review of eyes would help in early detection of damages and therefore a diagnosis and treatment.

This involves performing eye exams periodically, however, for most people is not affordable because the spaces where are these teams are central locations, so make a weekly, daily review or several times a day It is difficult due to the time and cost of transport. Added to this the necessary equipment to obtain the images are often expensive, plus they all are imported. Also to be considered are made primarily to take pictures of the pupil or retina; Three examples are shown in Table 1.

Equipment	Price (USD)
Retinal Camera Kowa nonmyd 7	$7,999
Scope Horus DEC 100	$6,000
No mydriatic retinal camera	$4,000

Table 1 Equipment for acquiring images of eyes

From the above revisions and regular eye exams with a team of moderate cost (about $ 600 USD, including computer equipment storage) would help detect systemic diseases; it should be noted that the team is a support tool for the specialist, and does not replace regular reviews recommended.

This paper begins with a brief explanation of the anatomy of the human eye, following the proposed system and conclusions

Anatomy of the human eye.

Vision is the sense of human beings that allows us to get a lot of information about objects and events around us, it is the dominant sense, so knowing their anatomy is important for the current project, in Figure 1 (human eye and its visible parts, 2014) an image of the human eye as we see in the "daily life" with their respective parties, of which the system will focus on the images, also called the sclera sclera shown.

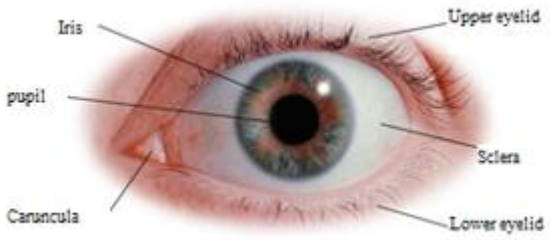

Figure 1 Human eye and visible parts

ISSN-On line: 2410-4191

Sclera

Sclera "is white. It is composed mainly of collagen tissue which gives it extraordinary strength and few blood vessels allowing the white color of the collagen fibers "(Faculty of Medicine, Catholic University of Chile, 2014).

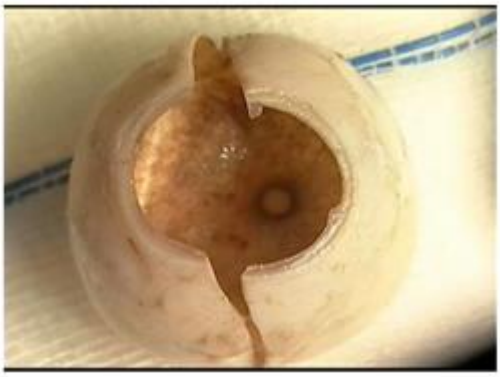

Figure 2 Sclera [7]

In Figure 2, which was obtained from (González del Valle, Alvarez Portela, Lara Medina Sanchez Celis, Barrajón & Rodriguez, 2012), the sclera after being extracted, showing their shape and color is displayed, it appears that is completely white and clear, so that a change in coloration indicate a disorder itself, which is rare, or a disease of some other organ of the body that is manifested in the sclera.

Note that in Figure 1 only you can identify a part of the sclera, so it is necessary to capture more than one image to obtain a larger surface, for it is proposed to capture at least five images with different eye movements for improve the analysis of the sclera.

Proposed system

The system consists of 3 main parts

Image acquisition: two commercial web cameras inexpensive one for each eye are used, we underline that the system must be affordable so it can be acquired by people of all social strata, and the characteristics are shown in Table 2.

Although the limited camera features are sufficient for the desired images, such databases are images of eyes among which UBIRIS (Proença & Alexander, 2005) used in the iris detection and its applications in its first version the resolution is 800 x 600 pixels, the same resolution as the cameras used.

Web Cam Perfect Choice	
sensor	CMOS SVGA, 480 Kpixels
sampling	30 fps
resolution	800 x 600 pixels (up to 8MP interpolated by software)
feeding	5 Vcc , 150 mA
dimensions	5.4 x 5.4 x 8 cms

Table 2 Characteristics of the webcam

Lighting: In the acquisition of the images is necessary that the lighting is uniform, so the preprocessing and processing will be reduced if these are used to detect the sclera, iris or some other part of the eye, and if there is a change in shape or color.

As the device is said to be small in size, so has chosen to use LED surface mount that emit white light, 3 (LED surface mount 0805W2C-KHC-B, 2015), with the characteristics obtained from (Data Sheet SMD LED 0805W2C-KHC-A, 2015) that are shown in Table 3.

ISSN-On line: 2410-4191

Figure 3 LED surface mount 0805W2C-KHC-B [9]

LEDs are placed around the lens of the webcam, which was previously separated from her deck, were tested with 2 and 4 LED, in both cases the results were satisfactory as shown in Figure 4 and Figure 5.

Importantly, the intensity of the lighting should be regulated to avoid any damage to the eyes, as the camera and the LED is confined in a cardboard tube that besides avoiding there external lighting, not allowing light to go out and improve the image; the regulation is performed by a microcontroller Arduino Mini by pulse width modulation, PWM for its acronym in English.

SMD LED 0805W2C-KHC-A	
material	AlGaN
Luminous intensity	200 – 300 mcd
voltage	2.9 – 3.5 V
current	30 mA
Viewing angle	120°
High	1.1 mm
Width	1.25 mm
Long	2.0 mm

Table 3 Characteristics of LED [10]

Capture and storage: To preserve the images, the cameras are connected via USBconnectors to a personal computer. A DellInspiron 3647 computer was used, with the characteristics described in Table 4 in this case.

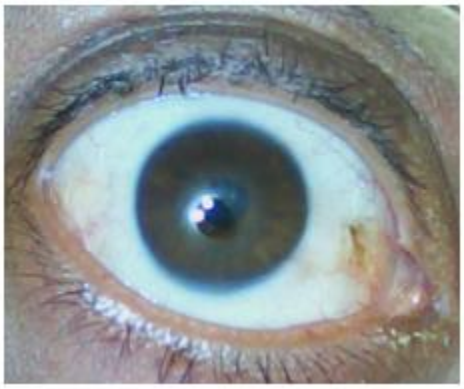

Figure 4 Image taken with 2 LED

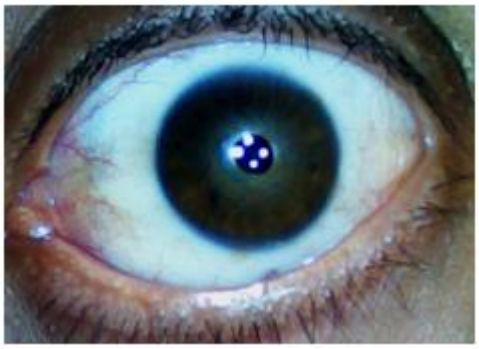

Figure 5 Image taken with 4 LED

The operating system used is Windows 8 by the manufacturer, the software for the acquisition and display of images is Mathworks Matlab R2012b installed.

Dell Inspiron 3647	
processor	Intel® Core™ i5-4460S
RAM	Memory 8GB Dual Channel DDR3 at 1600MHz
Hard disk	SATA de 1TB 7200 RPM
Optical drive	CD/DVD +/- RW 16x
video card	Intel HD integrated graphics
Display	Dell 20 inches

Table 4 Characteristics of the personal computer

With the same software interface was made to show both chambers and be able to take the two pictures with the touch of a button, which is shown in Figure 6.

Figure 6 Interface conducted in Matlab for two cameras

The code in Matlab to display both video streams from the cameras is as follows:

```
% Create video objects with a resolution of 800x600 pixels
camara_izq = videoinput ('WinVideo', 1 'RGB24_800x600');
videoinput camera = ('WinVideo', 2, 'RGB24_800x600');
figure ('Number Title', 'of', 'Name', 'Chambers');
% Subwindow left chamber
previo_izq = subplot (1,2,1);
axes (previo_izq);
tam_izq = image (zeros (800,600));
preview (camara_izq, tam_izq);
% Right subwindow camera
previo_der = subplot (1,2,2);
axes (previo_der);
tam_der = image (zeros (640.480));
preview (camara_der, tam_der);
```

Once both sequences are displayed with the "Taking Pictures" from the bottom of the interface, photographs are taken of the eye, the code shown below:

```
uicontrol ('String', 'Take Photo', ... 'Callback', 'figure (1), frame1 = getsnapshot (camara_der) figure, imshow (frame1) 4figure (2), frame2 = getsnapshot (camara_izq); figure, imshow (frame2); '...' Units', 'normalized', ... 'Position', [0.60 0.15 0 .07])
```

In most cases, preliminary tests are with the pupil facing forward so, it is proposed four photographs are taken with the pupil looking around, inside and outside as shown in Figure 7

Figure 7 Pupil the outside and inside

Furthermore two images with the pupil looking up and down as shown in Figure 8.

Figure 8 Pupil up and down

With the capture of the 5 images could observe a greater surface area of the sclera, making it possible to detect any changes in it would be very difficult with images from other databases, as these are only planned for iris detection (front view).

Once the images are captured, the names of the files to be stored is important to follow a pattern for the date, time and the "place" to where the pupil is oriented so that the file name is relatively short and is have as much information as possible without opening or display its properties, a format with the following options are proposed:

Eye: left (left), der (right)
Date: DDMMYY (day, month, year)
Time: hhmm (hours, minutes)
Pupil: CEN (center), int (internal), ext (external), arr (above), aba (below)
An example of the name of a stored image is:
der_121214_1000_cen.jpg

Information that can be deduced from the file name is: right eye photo taken on December 12, 2014 at 10:00 hours with the pupil center. This is important, as discussed 5 photos are taken by each eye, to have 10 images per acquisition, since being a device support in the diagnosis of changes in the sclera is necessary to perform one or more catches on different days and hours for a more reliable study.

Because one of the problems, as mentioned above, is the cost and time of transfer to visit the specialist; It arises generate a database as a medical record for each person.

The necessary basic fields are the name, age and sex, including the set of eye images taken which are already in the format mentioned, an example of the diagram to the database shown in Figure 9.

However this model may be appropriate based on user requirements or specialist.

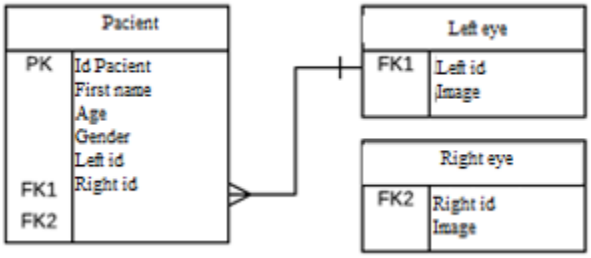

Figure 9 Diagram for the database

Results

The first tests and prototypes were developed with inexpensive materials such as cardboard rolls, silicone, cheap web cameras, lenses for welding to name a few.

When the improvement of image capture is achieved, the CAD design software is performed to suit the anthropometric measures of most people and the final prototype through a 3D printer.

Furthermore it has the support of the student community of the Autonomous University of the State of Mexico Zumpango CU, to begin forming a database of sclera. This is to innovate in an area which does not have such information.

Conclusions

A prototype of the system with low cost materials and small dimensions, with encouraging results is done because the captured images have a uniform illumination with an appropriate resolution; storage is also done automatically on a personal computer by pressing a button on the graphical interface.

ISSN-On line: 2410-4191

Captured images of the sclera preprocessing, processing or detection of the sclera have minor complications, because the images will be homogeneous, and the analysis and diagnosis of diseases may be more reliable.
It considered for future work the cameras are connected to the microcontroller and therefore the images are stored in the cache memory, whether external or internal, also taking advantage of the characteristics of Arduino could be sent wirelessly to a computer or smartphone for processing without a cable analysis.

By having a sufficient amount of database images with enhanced features, similar to those that exist in the study of the pupil or iris compile, and software for the processing, analysis and diagnosis of diseases will be scheduled.

It also intends in the future to provide the database obtained to facilitate investigations associated with the sclera.

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ISSN-On line: 2410-4191