EXTRACTION OF RELEVANT COLORED INFORMATION FOR IRIS CLASSIFICATION

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ABSTRACT

The purpose of this paper is to analyze some images recorded to process images that contained human iris, to identify the information contained in the iris circular zone and to remove the insignificant information about pupil and external zone of the iris.
We focus on image analysis and image enhancement by image filtering, edge detection and morphological operations like dilation and filling, but also we developed an approach that detects the center of a region.
Using these operations we can isolate only the important colored information about iris area which then may be used in other image processing algorithms needed for some classification of the iris.

1. INTRODUCTION

The iris became a much explored field, especially that some of specialists assert human iris contains unique and very important information about persons. Interesting works appeared in the medicine's domain (determination of some possible health conditions [1]), in biometrics domain (identification and recognition of a person [2]) and others.
What is iridology?
Some possible definition of term "iridology" could be:

- Iridology is the study of the iris structure, fibbers, and pigmentation to determine information about our physical and psychological structure.
- Iridology is the science of analyzing the delicate structures of the iris to identify the genetic constitutional structure of an individual. Each fibber, structure, colour, pattern and pigment in the eye provides a rich and detailed expression of our genetic behavioural and physical body.

So we may say that iris information contain some data about our genetically inherited tendencies, congestion and predispositions toward inherent health patterns.
The main conclusion is that if we possibly know from a young age what our weaknesses are, we can take action to find and treat them before a serious problem arises.
We concentrate on image processing, especially on image analysis and image enhancement by image filtering, edge detection and morphological operations. We developed an approach that detects the center of a region (which is helpful in this process).

In the first step we tried to collect some pictures that contained image of iris as clearly as we can.

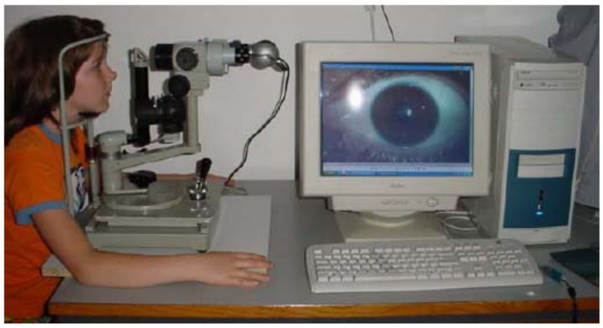

Fig. 1 The system used to take iris image
(bio - microscope, web-camera, computer)

Before starting the process that takes a picture of the iris, the utilized method is optimized by trying to standardize the conditions to photograph and to adapt it to our problem.
In the beginning we took the images with photo - digital camera (when the study starts). We observed that the images were disturbed by multiple reflection of light in the cornea zone and because that issue couldn't be eliminated without affecting the total information of the iris, we tried another method.
The second method of taking iris images was with an system named „bio - microscope" which is present in any ophthalmologic laboratory, so we used the Carl Zeiss Jena type SL Classic (f = 125) system (see Figure 1).
The advantage is that we can obtain standard images, in the same conditions of illuminating the photography room (the bio – microscope had an own system of illuminate using a lamp of 6V 30w) without appearance of the parasite reflections in the cornea area.
Though there is a reflection of the light but it can be adjusted to appear in the pupil area; so that issues would not affect the iris information (see Figure 2 a)).
The images was taken on the ocular of the bio-microscope, where it has been attached a web-camera Logitech Quick Cam Pro 4000.

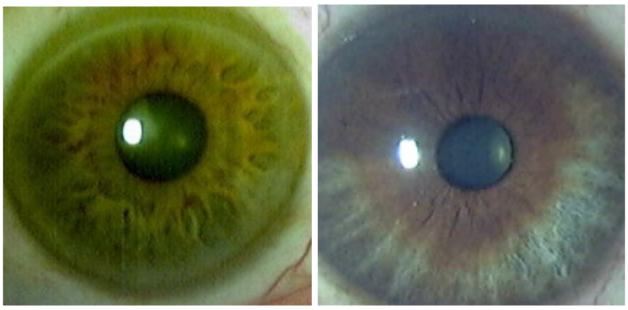

Fig. 2 a) Image showing the correct appearance of the reflection of light outside the iris area;
b) Image showing information disturbed by the reflection of light in the iris zone.

The resulting images were stored on the computer hard-disk at the same time that we register other information about the patient, like: age, colour of the eye, if the patient is a male or a female, and a lot of other ophthalmologic information.
In the recorder process of the iris image we take care that the iris plane to be in the frontal position and the line that join the internal and external edges to be horizontal (for image iris not being rotating).
We also take care that the dimension of the pupil to be the same or almost the same at all images, because with varying the pupil dimensions, we vary the information of the iris area (the largest the pupil diameter, the less information about the iris) and it create the impression of appearing or disappearing of some details.

2. METHODS

Some methods for isolate the information about iris have been developed (see Daugman [2]). The purpose of this paper is to identify the information contained in the iris circular zone and to remove information about pupil and external zone of the iris. We focus on image analysis and image enhancement [3][4] by image filtering, edge detection and morphological operations like dilation and filling.

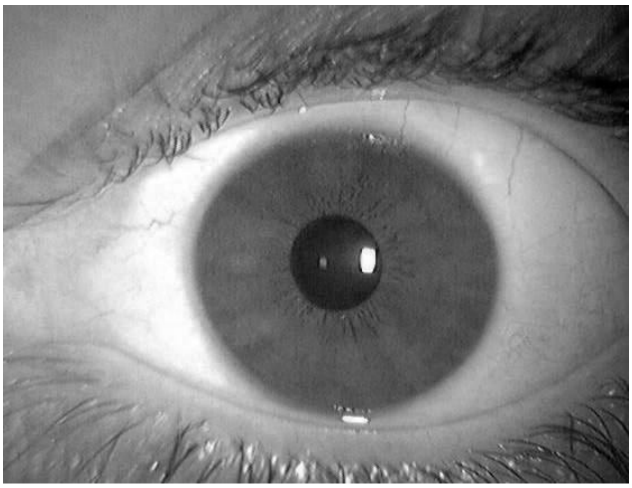

Fig. 3 Original coloured image of the eye;

2.1 Our algorithm

First step is to transform the original color image of the human eye (see Figure 3) into a grey image that contains only the center of the old color image. That center is obtained by a resizing operation with the lowest of the width and high (the two dimensions) of the image (see Figure 4a)).

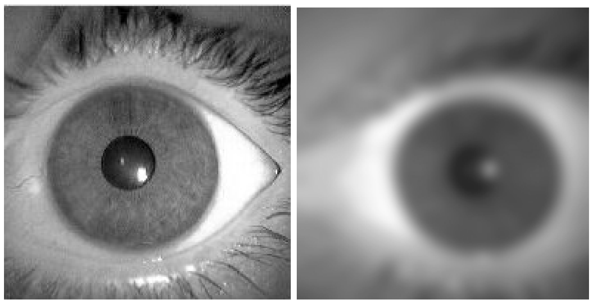

Fig. 4 a) Original grey image of the eye;
b) Gaussian filtered image

After that, the image contrast is improved by an operation that normalizes the value of the pixels. The resulted image is similarly with that one from the Figure 4a).

2.1.1 Detection of the iris centre

- The grey image from the Figure 4 a) is then transformed by filtering with a Gaussian filter (the resulting image can be seen in Figure 4 b));
- for the filtered Gaussian image a Canny edge detection is applied, and after that an operation of dilation will increase the contour of the iris (see Figure 5 a));
- finally, an operation of filling is performed (and the resulting image can be seen in Figure 5 b)).
- Applying our own algorithm to that binary image we obtained the center of that region and the large radius of the iris, where by large radius of the iris we mean the radius of the circle formed by the pupil and iris together. (in that case the center of the region is exactly the center of the iris)

The centre of the iris is detected in almost all the images that we verified, but there are some problems if the image quality is very poor or if the iris is of a very light colour.

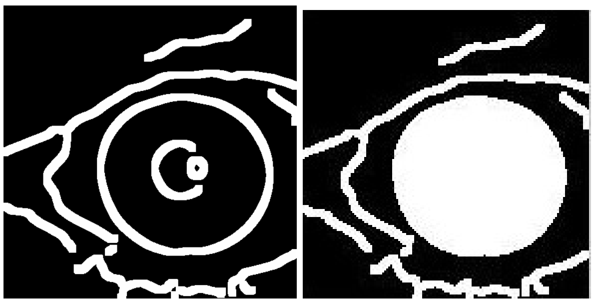

Fig. 5 a) Dilated Canny edge image; b) Filled image

2.1.2 *Detection of the pupil centre*

- Knowing the centre and the radius of the iris, we extract from the whole grey image only the image that contains the iris and the pupil (see Figure 6 a)).

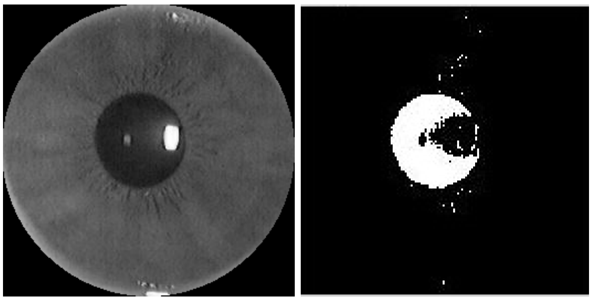

Fig. 6 a) Image containing the iris and the pupil;
b) Binary image representing the binary pupil.

- Then, from that image, as we know that the pupil is in general black (except a small area of white pixels due to the process of recording by digital camera) we extract the black or almost black pixels with a value of threshold and we obtain a image named “binary pupil” (see Figure 6 b)) .
- Applying to that binary image again of an edge detection (Canny method), dilation and filling (like in the section 2.1.1 detection of the iris centre, but now except the filtering with the Gaussian filter) we obtained a new binary image corresponding to the pupil (see Figure 7 a)).
- On the resulting image we use again our own algorithm to detect the centre and the radius of the pupil.
- As we know the center and the radius of the iris and of the pupil, we are successful in determine the iris region, like we can see in Figure 7 b).

Fig. 7 a) Binary image corresponding to the pupil;
b) The final image of the iris.

In ref [1] Dr. Sorina Demea make a personal classification of the iris colour, such as we can see in the Figure 8, coded with 1 (light iris), 2a, 2b, 2c (intermediate iris) and 3 (brown iris).

2.2 Results

Of course there are some parameters that can be changed during the algorithm, and some of these parameters are:

- The dimensions of the Gaussian filter that we apply to the original grey image to reduce the small details and to perform a better contour detection of the iris (we use a value of 43x43),
- The form and the dimension of the pattern used to dilate the image in the case of detection of the iris centre and in the case of detection of the pupil centre (we use for this parameter a value of 12, respectively 4),
- The threshold value with which we determine points from the pupil area (we choose a value of 0.2).

If someone modifies one or more of these parameters, the application could return better or poorly results, but these results are not depending only on these parameters, but also are highly connected with other aspects of the image, like contrast, colour of the iris, sharpness (or blur) of the picture, dimensions of the image and other.

2.2.1 *Gaussian filter dimension*

Using values between 40 and 45 for the dimension of the Gaussian filter, we obtain very good results referring to iris centre detection.
But even with these values, if the image containing the iris is noisy or with a lot of blur, or if the colour of the iris is very light blue (types coded with 1) the results are not good enough. The image obtained after applying the Gaussian filter (see Figure 4 b)) will contain few information, too poorly for a correct detection of the iris centre.
The same thing is happening in the case of higher values used for dimension of the Gaussian filter, although the initial image has no blur.
For lower values used for filter dimension, we get images in which the fine details are not eliminated and therefore the edge detection operation will find some other contour, possibly bigger than the iris contour, generating errors.

2.2.2 *Dilating coefficients*

The dilating operation is applied for detection of the iris centre and for detection of the pupil centre.
To detect the iris centre we used value of 12 for the dilating coefficient and we get good result. The value of this parameter is set to obtain a close contour of the iris according to the dilating operation.
If that contour is not obtained, we can generate successive dilating operations or we can choose from the start a higher value for this coefficient (some times we used the value 14, but it can be a higher value).
To detect the pupil centre we performed two dilating operations: first using a coefficient of 4 or 6 in function of the results obtained, and the second using a value of 10 or 15, these values varying according to the contours obtained.

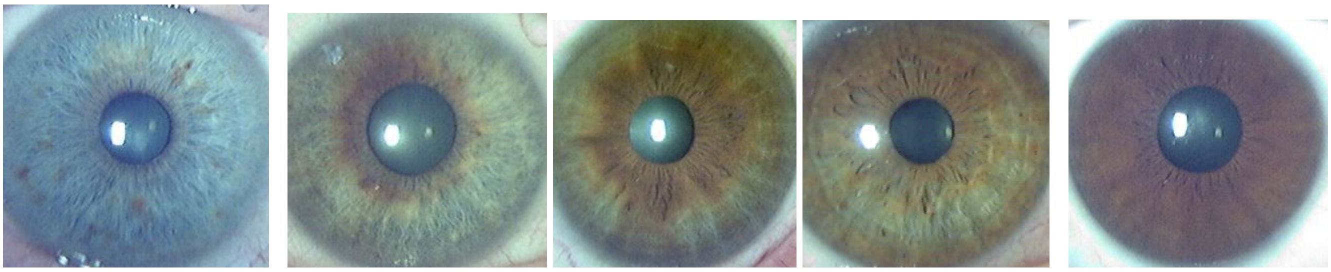

Fig. 8 Iris colour

a) light iris (coded 1); b) easy pigment migration iris (coded 2a); c) medium pigment migration iris (coded 2b); d) multiple pigment migration iris (coded 2c); e) brown iris (coded 3);

2.2.3 Threshold value

To detect the pupil centre a very important parameter is the threshold value which determines points corresponding to the binary pupil.
The lower the value of that parameter, the smallest number of the detected points corresponding to black pupil, and with the increase of the value we obtained more points from the pupil area, but we assume the risk to take some other points, external from the pupil area, but having a value close to black.
If that parameter is set to a very low value, we obtain just points very close to black, and if that parameter has a higher value, we obtain some other points, less close to black.
We use values of 15, 20, 25 and even 30 for this parameter; as a conclusion: we observed that lower values for the threshold parameter lead to good results for light iris, and for brown iris are more suitable the higher values of this parameter.

3. DISCUSSION

We tested our approach on a set of 300 images (acquired by us, using a bio - microscope and a webcam) and we obtained very good results.
We tried to find a set of parameters that allow the algorithm to work without the intervention of a person and that offer good results for most of the (tested) iris images; so we can say that it is an automatic algorithm.
The algorithm takes from 3 to 5 minutes (on a Pentium 4 2.4GHz, 256MB RAM PC), for images of size 640 by 480 pixels.

4. CONCLUSIONS

Using operations like those mentioned in this paper we try to develop an algorithm that can be generally applied to iris images with good results.
Extraction of relevant information concerning the iris may have an intense use in the future in many domains, but especially we think to medicine domain, where it is intended to find some connections between iris structure and some diseases, and if it possible to determine these characteristics as automatically as possible.
Our future work will follow a classification of this images based on some special criteria using artificial intelligence. We propose to make a classification of iris images originally from persons having an issue, for example from deaf persons.

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