MEDICAL DIAGNOSIS SYSTEM BASED ON IRIS ANALYSIS

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Abstract: The goal of this study is to present a system which is used to process iris images for medical purposes. Such a system should assist a diagnosis based on correlation between medical pathology and different sectors from the surface of the iris. Iris surface texture regions, which offer useful information, can be revealed using computerized texture and color analysis. Iridologists work showed that locations of those regions upon segmented iridology charts point out an interrelation between map sectors and internal body system medical pathology. Our goal is to automatically identify those regions and established an assist diagnosis. The final automatically generated diagnosis needs user approval, thus making the system semi-automatic.

Key words: *iris recognition, medical pathology, texture regions, diagnosis, Hough Transform.*

I. INTRODUCTION

The spectacular innovations of the biometric technologies, such as iris recognition, find themselves useful in new domains like person tracking or medicine. Because of its unique texture, color, reliability, and simplicity compared to other biometric methods, the eye's iris gained lot of attention in the last years. The analysis of one's iris pair can reveal information about unbalances in health of its internal body organs. The alternative medicine domain which deals with iris based diagnosis is known in the literature as iridology. Iridologists see eyes and iris, the state of health 'windows' of the human body [1]. One useful tool for the iridologists are iris charts. The iris charts, divide the iris surface into a finite number of segments, each segment being associated with an internal organ or system.

Designing and implementing an automatic or semi-automatic biometric system which deals with iris or eye image processing, can became handy for iridologists. The advantages of a computer based analysis are: precision in detecting the boundaries of the iris, precise color identification, optimized chart matching. The role of the user is very important. Based on this remark, the system should assist in diagnosis, the final decision, being approved by the user.

The paper is organized as follows: the presentation of the techniques and methods used in the implementation is illustrated in Section II. Section III contains the experimental results of the system. The comments regarding the subject of this paper are delivered in the section IV.

II. IRIS RECOGNITION AND TEXTURE ANALYSIS SYSTEM

First target in iris analysis consists of eye images and their acquisition. The optical system used to obtain the images used for this approach, is described in [2]. Detailed description and functionality of the optical system is not the topic of the current paper. General functional schematic, of the iris recognition and diagnostic implemented system is described in the Fig. 1. The three consecutive steps (iris recognition, analysis of the iris, and diagnostic generation), point out the functionality and efficiency of the system.

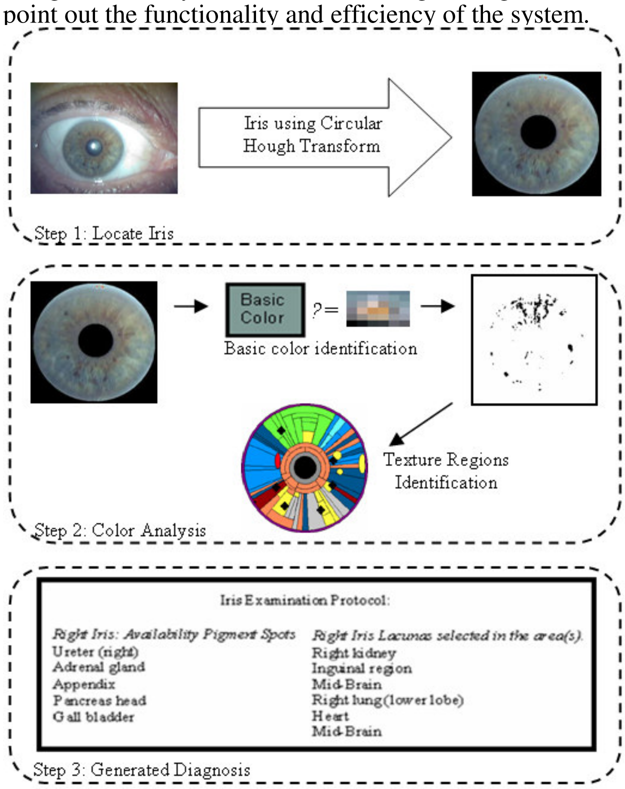

Figure 1. General Overview of the System: 1) Iris Recognition,2) Iris Analysis 3) Diagnostic Generation.

Starting from the assumption that the eyes are possible alike, the iris analysis proves the variance and uniqueness of the eyes. All iris recognition and processing methods will be

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applied independently for each eye. The iridologists are using this detail in the examination, a diagnosis is considered to be complete accurate only after the analysis of both eyes is realized.

II.1 ***Recognition and Identification of the Iris***

The iris is the target of our study. The first task is to locate correctly the iris from images displaying the eye. This means to demarcate both boundaries of the iris. The external boundary is the region between the iris and the sclera surrounding it. The iris is enclosing the pupil, the zone between the iris and the pupil being the inner boundary of the iris. Due to the circular shape of the iris, the appropriate way to approximate its boundaries is by use of circle or ellipse. In order to approximate and detect circular shapes inside images, there are a few well known methods. The automated iris recognition concept has been initially proposed by Flom [3] and Safir [3]. John Daugman [4] used multi-scale squaring wavelets to extract texture and the boundary recognition is done using Gabor wavelet method. The integro-differential operators combination method, was introduced by C. Tisse [5], L. Martin [5].

In our study we used another useful method, the Circular Hough Transform (CHT). The CHT is a standard computer vision algorithm that can be used to determine the geometrical parameters for a simple circle, present in an image. The main advantage of the Hough transform technique is its tolerance for gaps in feature boundary descriptions and its robustness to noise. Once the boundaries of the iris are identified correctly and its surface is extracted, the analysis of the iris surface can be done.

II.2 ***Iris Color Analysis***

The iris pattern analysis assumes: identifying the basic iris color, locate the particularities on the surface of the iris, associate those regions upon segmented iridology charts. An automatic mechanism for pattern analysis can be implemented. using special techniques of image processing.

First important texture aspect regarding the iris is it's color. Iris color is a polygenic trait and is determined primarily by the amount and type of pigments present in the eye's iris. Color variations among different irises are typically attributed to the melanin content within the iris stoma. The density of cells within the stoma affects how much light is absorbed by the underlying pigment epithelium [2]. The amount of light within the region where the person is living has an important influence on the eye color. There are three main colors of the iris encountered: brown green and blue. Those color variation are presented bellow, (Fig. 2).

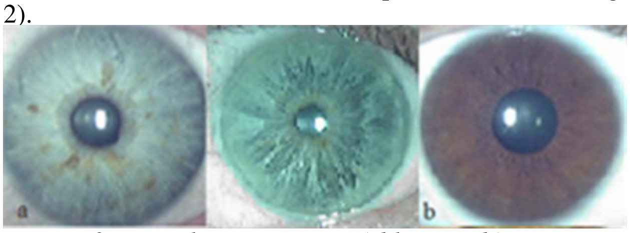

Figure 2. Iris color variations: a) blue iris, b) green iris, c) brown iris.

For example, green eyes have a lot of yellow and some brown, making them appear green. Blue eyes have a little yellow and little to no brown, making them appear blue. Gray eyes appear gray because they have a little yellow and no brown in them. Brown eyes appear brown because most of the eye contains the brown color. Brown is the most common, blue is rare, and green rarely [2]. The solution for identifying the basic iris color is simple. All the dominant colored iris regions should be identified and their color extracted.

The useful method in identifying the basic color is the mean pixel luminance value computation. The mean computed for a data set represent the sum of all the values divided by the total values number. The mean of pixels in an iris image is equal to the sum of all pixels value divided by the total no of pixels within the image.

On the surface of the iris there are darker or lighter pixel variations, stronger than the basic color. When computing the mean of the surface pixels, the values from those regions will influence the result, the resulting mean values being erroneous. To eliminate this inconvenience the median technique is used. The median performs an averaging on a given set of data, eliminating outliers. The outliers are the values seen as extreme upon the data set. This makes the median more suitable for skewed data sets. When applying the median upon a pixels data set, the pixels from the dark and light regions will be considered outliers. In this case their value will not influence the final value of the median result, which is the resulted basic color.

Another method presented in the literature for basic iris color identification is the region segmentation. A proper presentation of the method is described in [6]. Taking into consideration the fact that both irises are skewed, the basic color identification should be done independently for each of them. The result will prove that the color lies in the same color range, but the RGB values of the color are not the same. As mentioned before there are color discontinuities within the surface of the iris. Those discontinuities are the region of interest, or texture spots.

II.3 ***Iris Pattern Analysis***

Identifying the interest regions is the next step in the surface analysis process. The iris surface has an impressive and unique texture. At a close look the iris texture presents some regions of connective tissue generally extend in the radial direction, called radial furrows. The iridologists claim that on the surface of the iris during life some variation of texture can appear. Based on the variations shapes and sizes those can be classified and identified. Most common ones are considered anatomical formations: rings, radial folds, vaults. All other strong color variation, or texture modification are need to be identified and labeled, darker or lighter spots or regions within the iris surface. Different sample of texture variations are presented in Fig. 3.

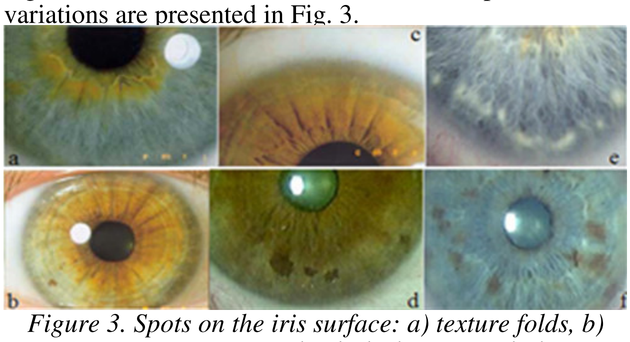

Figure 3. Spots on the iris surface: a) texture folds, b) texture rings, c) texture volts d) dark spots, e) light spots f) dark and light spots on the same texture.

Identifying those regions it is the next stage in the system implementation, as mentioned in the diagram from Fig. 1. In order to identify the dark and light regions upon the texture first step is identification of the basic color. Together with the basic color a threshold value is also chosen, in order to establish two color intervals. If the other pixels colors have values belonging in the interval defined for dark regions, then all those pixels are declared dark meanwhile all the pixels belonging to the light interval are light. Based on the pixels coordinates a map of interest dark/light regions can be obtained (see Fig. 1). The identified regions, interest regions, can be associated with the state of health variation of some internal organs inside the body.

According to this iridology a person's state of health and disease can be diagnosed from the color, texture, and location of various pigment flecks in the eye. Some also claim that the eye markings can reveal a complete history of past illnesses as well as previous treatment. One textbook, for example, states that a white triangle in the appropriate area indicates appendicitis, but a black speck indicates that the appendix had been removed by surgery [1]. On their work and studies iridologists have managed to implement maps and charts which prove that illness of internal human body sufferance are recorded on the iris's surface. An iridology chart is the segmented representation of both left and right iris [7].

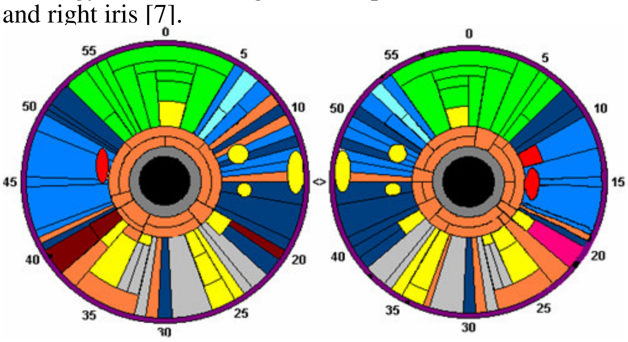

Figure 4. Right and left iris Map (according to G.Abramov), 10 colors segments representing all importantinternal body subsystems.

Every segment has associated an internal body organ or apparatus projection. A complete history of past illness for each internal organ or apparatus can be established, based on the correlation between the identified interest region and its location on the iridology chart. Fig. 4 presents an example of an iridology chart drawn by G. Abramov [2]. This chart is used in the system implementation. In the above illustrated iridology chart, the main internal body subsystems are represented using different colors. Systems starting from the Cardiovascular System to Ophthalmology are represented in 10 color palette. The iris chart is drawn in pair, one representation for the left iris and one for the right iris. It can be easily assumed that all the subsystems are represented on both the left and right side of the chart [2]. In order to correct estimate and express the illness history for one person all the time both irises must be analyzed. Using this iridology chart the last task regarding the analysis of the iris can be performed.

II.4 *Final Assist Diagnosis Generation*

The final step of the analysis system is represented by the final assist diagnosis generation. Once the dark/white texture regions are identified upon the iris surface, the localization on the iris chart should be simple. From the iris image, we have obtained an image in which the interest regions are marked as black pixels and all the others white. Each black pixel will have a known (x,y) location on the image. In order to obtain a precise location of spots on the iris chart, the dimension of the chart and spots image are matched. If we search on the chart image the locations (x,y) obtained from the spots image, and read their luminance values we can see which spot belong to which sector. In this way we can associate each spot to its corresponding sector from the chart. This mechanism is presented in Fig. 5. The internal subsystems are represented with colored segments on the chart, on both left and right mapped irises.

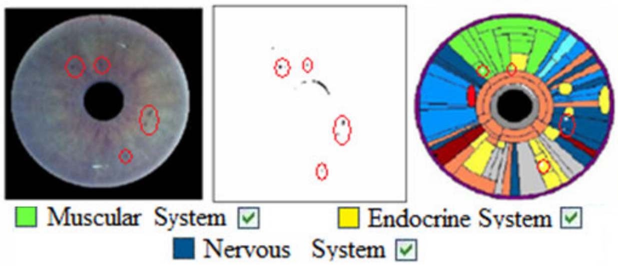

Figure 5. The Diagnosis Generation Mechanism: iris texture image; spots image chart; color matching.

While some of the systems have correspondence only on the left or right iris chart others have on both. For example: Cardiovascular System or Respiratory System, have projections on both irises, while Dermatology has only on the right. For an optimum complete assist diagnostic generation both irises need to be analyzed, taking into consideration only the dark/light regions and their location the segmented charts. Several constraints are imposed to avoid troubleshooting.

The images dimensions involved in the processing (iris images and chart images) need to be identical. If the identified spots regions are within 5 to 10 pixels area range those interest region are considered not useful in the diagnostic process.

The role of the user is important when giving the final diagnostic, thus making the system semi automated. The diagnostic must be approved by an iridologist or a doctor, because there are tricky regions which sometimes do not obey the imposed rules. In order to allow the user to interact as simple as possible with the analysis system a friendly and interactive user interface was included.

III. EXPERIMENTAL RESULTS

The independent proposed system was developed using Matlab, Technical Computing Language. As input, the system will receive a pair of images containing left and right eye. The results are presented as a diagnosis diagram, pointing out the issues for the identified internal body subsystems.

The system was tested for 50 pair images. All images have the same size (800/600 pixels), and were stored without compression. The images were provided by the Oftalmological Center of Investigation REVIEW.

To prove the functionality of the system a a test upon a pair left and right eye images is presented. First the left and right iris from the pair eye images is extracted, using CHT method. CHT is applied twice for detecting the circles representing the inner and outer iris boundaries. The obtained iris surface image is stored independently for further processing in 'PNG' or 'BMP' formats, without compression. Then the texture analysis begins with, basic iris color identification. The color identification must be done for both irises, obtained from the eye images. Color identification is done using the pixels median within the texture.

The iris texture is separated in three concentrically segments. On the middle segment, color detection is done using pixels median computation, because it is considered that on this region the ratio accumulation of the pigment/surface is optimum. The median is computed independently on each R,G,B channels.

In Fig. 6 are presented the results of basic color identification for the input pair images.

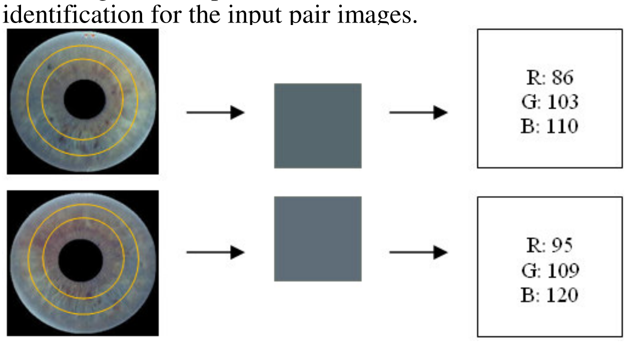

Figure 6. Basic iris colors calculation method, median sector selection and median computation.

The identification of dark/light spots regions, is done comparing each pixel value with the basic color value. When comparing the pixels we use a threshold parameter. The role of the threshold is to ensure a narrow interval for the spot regions. The dark spots are located in the interval [0,basic color-threshold] and the white ones in [basic color+threshold,255], for each RGB channel. The obtained regions are stored as individual images.

Fig. 7 presents briefly the mechanism of dark spots region identification. As one can see the identification is realized on each left and right iris.

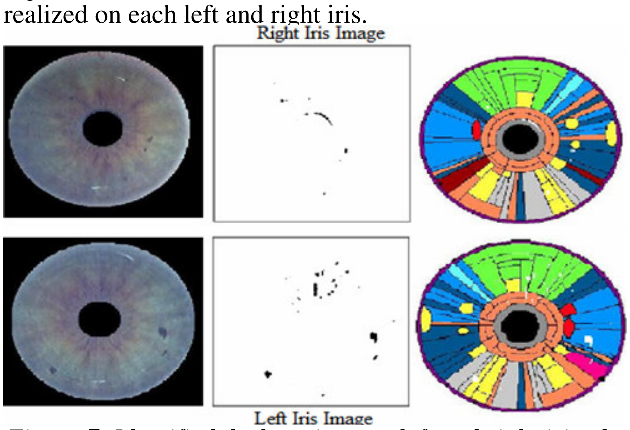

Figure 7. Identified dark regions on left and right iris, the value of the threshold is 30 for the left iris and 35 for the right one.

The last step, of texture analysis, is spots location on the map. The sizes of spots image and chart image must be identical, so the chart dimensions are adjusted accordingly. From the spots image we obtain the (x,y) coordinates of the pixels representing the spots. Reading the color information of the pixes locate at (x,y) coordinate on the chart image, the association spot segment on the chart image is realized. Knowing the selected segments from the chart, an assist diagnosis can be established.

The diagnosis is presented as a check box table, on column for the internal body system or apparatus name, one column of check boxes for the left iris and one for the right. If a dark/white spot is located on the segment corresponding to one apparatus or system then on the corresponding left or right check box column the field is marked otherwise it remains empty. At this point the user can acknowledge and adjust the final diagnosis.

To test the performance of the system we have compared the results obtained for each image pair with medical records of the patient whose eyes were analyzed. Our system estimation matched 70% with medical records.

The results are influenced by the quality of the input images, the efficiency of the map and the skill of the user.

IV. CONCLUSSIONS

The goal of the current is to present the design and functionality of an automatic solution for iris texture image analysis. Using the studies and experience gather by iridologists, which can prove that iris texture analysis care provide useful information about the patient state of health, the system may come handy offering a reliable solution compared to the manual examination.

The system was implemented using image processing techniques and algorithms implemented in Matlab. Because it need a user approval for the diagnostic the system as find it is semiautomatic, but easy to use due to its friendly interface. The system is useful for iridologists but it has some drawbacks.

In the case of large scale images the computational time may be high and the level of memory used, an increased one.

Color identification can be erroneous in the case of low level image quality, or texture malformations. The recognition of the spots region may be wrong in the case of false color identification, or improper chart dimension synchronization or improper chart matching.

The efficiency of the final diagnosis is influenced by the level of detail of the iridology chart, and of course by the skill of the user.

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