Cholesterol Presence Detection Using Iris Recognition

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***Abstract* — Arcus senilis is a whitish ring-shaped or bowshaped deposit in the cornea. It is recognized as a sign of hyperlipidemia and is also associated to coronary heart disease (CHD). Iridology is an alternative method to detect diseases using iris's pattern observation. Iridologists believe that the whitish deposit on the iris is sign of heart diseases. We develop the simple and non-intrusive automation system to detect cholesterol presence using iris recognition (image processing). This system applies iris recognition method to isolate the iris area, normalization process and lastly determining the cholesterol presence using thresholds and histogram method to determine the threshold value. The result showed that the incidence of cholesterol was high when Eigen value exceeds a threshold value.**

***Index Terms* — Arcus-Senilis biometric-identification, Cardio-vascular diseases, Corneal-arcus, Iridology, Iris recognition.**

I. Introduction

The objective of this paper is to explain how the presence of cholesterol in blood vessel can be detected by using iris recognition algorithm. Cholesterol or Hypercholesterolemia is a high level of lipid in the blood poses a significant threat to person's health. It is an indication of elevated cholesterol

This may lead to cardiovascular diseases. It is caused by extracellular lipid deposition in the peripheral cornea, with the deposits consisting of cholesterol, triglycerides cholesterol esters, and phospholipids. The current technique used to measure the cholesterol level is by doing blood test and the test is known as lipoprotein profile. The lipoprotein profile is an invasive method which causes discomfort amongst many patients. A laser based technology as non-invasive technique to measure blood cholesterol through skin. They proposed infrared (IR) absorption spectroscopic as the characterization of cholesterol in the skin. Based on [4], skin contains approximately 11 percent by weight of all body cholesterol and when severe coronary artery disease is present, the numerical values acquired with the skin cholesterol test increases. Thus, the palm test is not useful in identifying coronary artery disease and it is not intended to be used as a screening tool to determine the risk for coronary artery disease in general population. In order to have a simple and nonintrusive means to be as a screening tool to detect cholesterol, we found out that high cholesterol can be detected from changes in iris pattern and they are called Arcus Lipoides (Arcus Senilis or Arcus Juvenilis). The Arcus senilis is a greyish or whitish arc or circle visible around the peripheral part of the corner in older adults [10]. Lipid deposits causes Arcus senilis in the deep layer of the peripheral cornea and similar discoloration in the eyes of younger adults (arcus juvenilis) is often associated with high blood cholesterol [4]. This statement proves that iris pattern can be analyzed and used as another technique to detect cholesterol presence in body.

II. Introduction Eye Image

In this process the sample of eye is very important because analysis base on the data from human eyes. This solid iris image is used in this system to verify the presence of cholesterol. Thus it is vital to isolate this part (iris) from the whole unwanted part in the eye (sample). This separation or segmentation is the process of remove the outer part of the eye (outside the iris circle), to get solid iris image that useful for localization the cholesterol lipid. The quality of the images is very important to get the best result, thus the images should not have any impurities that can cause miss localization. These impurities include the flash reflection from camera and wrong angle of image capture. In this project the sample of therefore, we use images obtained freely from a few free database sources that can these databases available online.

III. Hough Transform

The Hough transform is a standard computer vision algorithm that can be used to determine the parameters of simple geometric objects, present in an image, for e.g., lines and circles. The circular Hough can be employed to deduce the radius and center coordinates of the pupil and iris regions. The automatic segmentation algorithm based on the circular Hough transform is employed .Firstly; an edge map is generated by calculating the first derivatives of intensity values in an eye image and then set the threshold base on the result. Then from the edge map, votes are cast in Hough space for the parameters of circles passing through each edge point. These parameters will be the center coordinates and the radius, which are able to define any circle according to the equation:

$$xc^2 + yc^2 + r^2 = 0$$

A maximum point in the Hough space will correspond to the radius and center coordinates of the circle best defined by the edge points. We also make use of the parabolic Hough transform to find the eyelids, by approximating the lower and upper eyelids with parabolic arcs, which are given as;

$$((-x-hj)\sin.j+(y-kj)\cos.j)^2 = aj((x-hj)\cos.j+(-y-kj)\sin.j)$$

It controls the curvature, which is the peak of the parabola and is the angle of rotation relative to the x-axis. In edge detection step, According to reference we bias the derivatives in the horizontal direction for detecting the eyelids; whereas the vertical direction is used for detecting the outer circular boundary of the iris. Motivation for is, the eyelids are usually horizontally aligned; also the eyelid edge map will distorted the circular iris boundary edge map if using all gradient data. Only the vertical gradients are considered for locating the iris boundary will reduce influence of the eyelids when performing circular Hough transform, and all of the edge pixels defining the circle are not required for successful localization. These make more efficient and accurate circle localization; because there are few edge points to cast votes in the Hough space.

IV. Segmentation

This segmentation (localization) process is to search for the center coordinates of the pupil and the iris along with their radius. These coordinates are marked as ci, cp where ci represented as the parameters $[xc, yc, r]$ of the limbic and iris boundary and cp represented as the parameters $[xc, yc, r]$ of the pupil boundary. It makes use of [6] to select the possible center coordinates first. The method consist of threshold followed by checking if the selected points (by threshold) correspond to a local minimum in their immediate neighborhood these points serve as the possible center coordinates for the iris. These radius values were set manually; the input for this function is the image to be segmented and the input parameters in this function including rmin and rmax (the minimum and maximum values of the iris radius). The range of radius values to search for was set manually, depending on the database used. The output of this function will be the value of ci and cp which is the value of $[xc, yc, r]$ for the pupilary boundary and the limbic/iris boundary and also the segmented image. For all the above process the use of the Hough Transform is made as discussed in the above section. However, the Segmentation process was not able to perfectly reconstruct the same pattern from images with varying amounts of pupil dilation, As the deformation of an iris results in small changes of its surface patterns.

V. Normalization

After the iris is localized, the next step is normalization (iris-enrolment).From the process of normalization, the segmented image of the eye will give the value radius pupil and the iris. This image will be cropped base on the value of iris radius, so that the unwanted area will be removed (e.g. sclera and limbic),arcus senilis is described as a yellowish-white ring around the cornea that is separated from the limbus by a clear zone 0.3 to 1 mm in width. Normally the area of white ring (Arcus Senilis), occurs from the sclera/iris up to 20 to 30 percents toward to pupil, thus this is the only the important area that have to be analyzed. In rectangular shape analyze can be done either from top to bottom or from bottom to top. (J. Daugman, 2004) describes details on algorithms used in iris recognition. He has introduced the Rubber Sheet Model that transforms the eye from circular shape into rectangular form and it is shown in Fig.1. This model remaps all point within the iris region to a pair of polar coordinates (r, θ) where θ the angle is $[0, 2\pi]$ and r is on the interval $[0,1]$ .Since the pupil can be non-matching with the iris therefore it need to remap to rescale the points depending to the angle around the pupil and iris. This formula given by:

$$r' = \sqrt{\alpha}\beta \pm \sqrt{\alpha\beta^2 - \alpha - r_1^2}$$

With $\alpha = o_x^2 + o_y^2$

$$\beta = \cos(\pi - \arctan\left(\frac{o_y}{o_x}\right) - \theta)$$

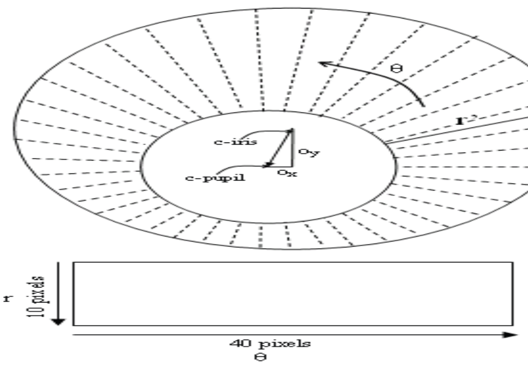


Figure 1. Outline of normalization process

The shift of center of the pupil relative to the iris center, this given by O_x, O_y and r' is the distance between edge of pupil and edge of the iris at the angle θ around the region, and is the radius of the iris. Whereas the remapping formula gives the radius of the iris region 'doughnut' as a function of the angle θ. A constant number of points are chosen along each radial line, hence a constant number of radial data points are considered, irrespective of thinness or wideness radius is at a particular angle. The normalized pattern was created by backtracking to find the Cartesian coordinates of data points from the radial and angular position in the normalized pattern. From the 'doughnut' iris region, the normalization generates a 2D array with horizontal dimensions of angular resolution and vertical dimensions of radial resolution. It is difficult to do analysis if the image is in the original form therefore the image needs to be wrapped to transform the nature from circle to rectangular shape.

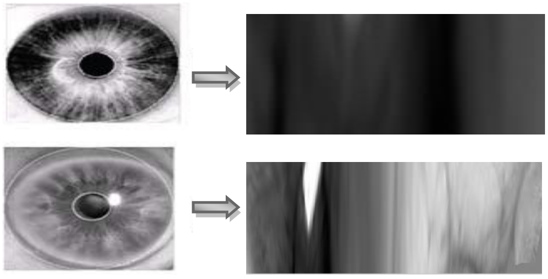


Figure 2. Illustration of the normalization process, normal and illness eye.

VI. Cholesterol Detection System

The process starts with obtaining number of normal eyes and illness eye images (arcus senilis). The next step is to isolate the actual iris region in digital eye image. The isolation process needs to be done to segment the outer boundary for the iris and the inner boundary for the pupil. This can only be done by searching the center point of the pupil given by x and y axis as propose by [4]. Hough transform is used to detect edge of the iris and pupil circle. The algorithm processes the image with the matlab software; the image from the database gives wrong detection on pupil boundary because segmentation on pupil is on the illumination light rather than segmenting the pupil boundary. This will fail to determine the edge of pupil but it will detect the edge of the impurity illumination light, which will effect the segmentation quality eye image, cause imperfection in detecting the iris and pupil boundary region of the eyes. But luckily the significant area of white ring (Arcus Senilis) lay at the boundary of sclera or iris up to the pupil, so as long as the segmentation done correctly on the iris it can considered succeed. This segmentation image will be crop base on the value of iris's radius. Even though the pupil boundary is not accurately detected in this segmentation process, these images still can be accepted since the incidence of cholesterol normally occur from limbic up to pupil which is 30 percent from overall normalization image. Therefore for this kind of segmentation we consider the correct segmentation of iris boundary rather than pupil boundary segmentation. (Border of iris) so this result can be used. Next, the image has to be analyzed and this can only be done if it is transformed to normalized polar coordinates using Rubber Model. Since the "sodium ring", terminology given in iridology, or arcus senilis for the grayish or whitish arc in iris is only available at the bottom of this coordinate, thus only 30% of the iris part is considered in the normalization. Lastly, to determine whether the eye has the ring, and image histogram has to be plotted .The algorithm assumes the image contains two classes of pixels (e.g. foreground and background) and finds the optimum threshold separating the two classes so that their combined spread (within-class variance) is minimal.

VII. Results

A clear view for this cholesterol detection system demonstrates in Fig. 3 whereas shows the entirely process of the cholesterol detection system using iris recognition and image processing algorithm. This process comprises the following actions:

a) Eye images acquire from database (medical web) or from digital camera.

b) Process of pupil and iris localization and segmentation, for classifying the required region.

c) Attain normalization iris from circular shape to rectangular shape with full image.

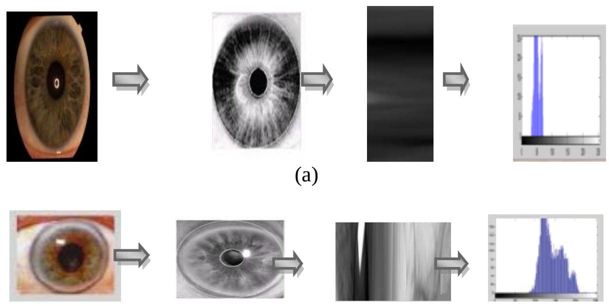
d) Crop the normalization iris to 30% from full image, (as shown in Fig.2

e) Analyze the normalization iris to get the histogram value.

f) The histogram for the image having cholesterol ring is having the more values concentrating in the area of higher intensity (near to 255) and for normal image the values are concentrated near the lower intensity level (near to 0) as shown in the Fig. 3(a) and (b).

g) Results "Sodium ring detected" or "not detected" will be display in MATLAB window. Here sodium ring refers to the cholesterol ring (Arcus Senilis).

The result is based on the value obtained in the automated detecting presence of cholesterol (ADCP). The algorithm output will be either "sodium ring is detected" or "no sodium ring is detected" depend on the sampling eye images processed by the ADCP. By using this ADCP will determine either someone have the symptom of the cholesterol presence or not. The result however is display in command window, yet the program can be executed and display using Graphic User Interface (GUI), where MATLAB has tool to perform it. The below Fig shows the result obtained after applying ADCP on both cholesterol affected as well normal eye image.



(a)

(b)

Figure 3. (a) Stages in cholesterol detection in diseased eye, (b) in normal eye.

VIII. Conclusion

This work introduces a non-invasive method and iris recognition to detect the presence of cholesterol known as hyperlipidemia by the sign of existence arcus senilis in iris pigmented. It can prove an advantageous method for the cholesterol detection than the other past medical methods available. Similar opinion support by iridology practitioner call this symptom as sodium ring refer to arcus senilis sign of cardio heart diseases (CHD). This program also can be used to determine the eye problem due to other type of eye diseases such as cataract, glaucoma, diabetic, tumour etcetera.

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