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The banner features a dark blue background with a satellite-style image of Earth. On the left, there are three circular logos: the top one is 'ECS' in a white circle, the middle one is 'The Electrochemical Society' with a stylized 'ECS' logo, and the bottom one is 'THE KOREAN ELECTROCHEMICAL SOCIETY'. The main text in the center reads 'Joint International Meeting PRIME 2020 October 4-9, 2020' in white and blue. Below this, a light blue bar contains the text 'Attendees register at NO COST!' in dark blue. On the right side, there is a large white logo for 'PRIME' with a stylized 'P' and 'M', followed by 'PACIFIC RIM MEETING ON ELECTROCHEMICAL AND SOLID STATE SCIENCE' and '2020' in white. At the bottom right, a dark blue bar contains the text 'REGISTER NOW' in white with a right-pointing arrow.

Detection of Cholesterol Levels by Analyzing Iris Patterns using Backpropagation Neural Network

L B Rachman¹ and Basari^{1,2}

¹Department of Electrical Engineering, Universitas Indonesia, Kampus UI Depok, West Java, Indonesia

²Research Center for Biomedical Engineering, Universitas Indonesia, Kampus UI Depok, West Java, Indonesia

E-mail : liani.budi@ui.ac.id, basyarie@eng.ui.ac.id

Abstract. Detecting cholesterol levels with iridology can be an alternative method for checking human's health. Iridology analyzes diseases and weaknesses of the body based on the shape and structure of the iris. This study uses image processing to analyze patterns in the outer portion of the iris bordering the sclera. Colored iris images are converted to grayscale to facilitate image processing. The results of color conversion still contain noise so that the Median Filter is used to eliminate noise in the image. The iris image which is still in the form of polar is transformed into a rectangular shape. This is used to facilitate the taking of the area to be analyzed. Next, the iris image is filtered using a Gaussian Filter to get smooth results. This is used to remove lines on the iris image after being converted into a rectangular shape. From the filtered image, the statistical value is calculated using the Gray Level Co-Occurance Matrix (GLCM). This is a comparison method which will produce several statistical characteristics, namely Energy, Correlation, Contrast, and Homogeneity. The four statistical characteristics will be used as input data for training using the Backpropagation Neural Network method that will produce output in the form of normal cholesterol or high cholesterol. The results of experiments on thirty images obtained an accuracy of 96.67%.

1. Introduction

According to health, an alternative method to detect cholesterol levels is by observing the iris patterns. Iridology is a technique of analyzing diseases and weaknesses of the body based on the shape and structure in the iris which is placed around the pupil [1]. Iris of the eye can describe the body system either its strengths or weaknesses, the stage of the disease and the changes that occur in the body according to natural processes. Within the iris of the human eye there are 7 zones or primary layers depicting all the functions and organs of the human body. The imbalance in the body system can be detected based on the 7 zones iris layer. Zones of iris layer image is shown in Figure 1.

High cholesterol can be identified by the presence of a cholesterol ring on the iris which is a dark white circle on the outer portion of the iris bordering the sclera. In the zone of the iris layer, the cholesterol ring is located on layer 7. The condition of the iris with normal cholesterol is shown in Figure 2 and the condition of the iris with high cholesterol is shown in Figure 3.



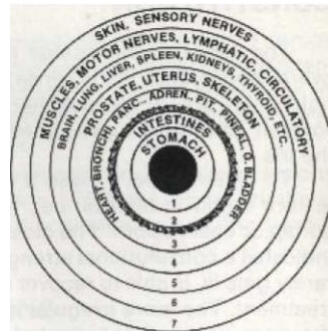


Figure 1. Zones of iris layer



Figure 2. Condition of eye with normal cholesterol



Figure 3. Condition of eye with high cholesterol

Iridology analysis is usually done manually by iridology practitioners or by experienced people because iridology can be studied [2]. Iridology practitioners usually only look directly into the patient's eyes with the help of a flashlight. So that manual observation can produce diagnostic errors. To avoid this, the use of software can be a solution. Iris image processing with matlab programming can detect disorders of the body's organs quickly, efficiently, and accurately [3]. Research with image processing to detect cholesterol levels has been done before. Research conducted by [4] combines Fuzzy Local Binary Pattern (FLBP) and Linear Regression methods. The resulting accuracy is 91.40%. Based on this research, this time, the author tries to use a combination of GLCM and Backpropagation Neural Networks to improve accuracy. This combination of methods is expected to be more effective and efficient in detecting cholesterol levels.

2. Proposed Method

Figure 4 shows the steps of this research:

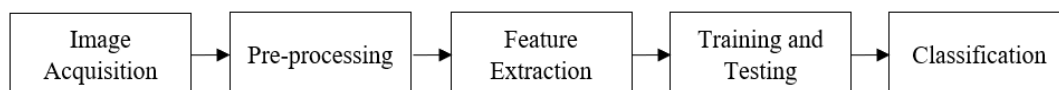


Figure 4. Research steps

2.1. Image acquisition

The image used in this research is a color image with a size of 300 x 300 pixels. Thirty images used in this study consisted of 10 images with high cholesterol indication and 20 images with normal cholesterol indication. The thirty images are used for training and testing. Images are obtained from UBIRIS database.

2.2. Image pre-processing

The purpose of this stage is to get a part of the iris image that will be analyzed only. The stages of image processing shown in Figure 5.

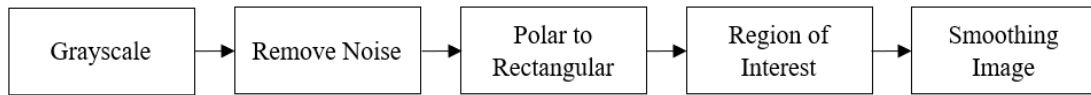


Figure 5. Image pre-processing steps

2.2.1. Grayscale. To facilitate image processing, color images are converted into grayscale. The 24-bit RGB input model image is converted to a grayscale image with a depth of 8 bits or has a value of 0-255. The color image of iris is shown in Figure 6 and converted grayscale image of iris is shown in Figure 7.



Figure 6. Colored image

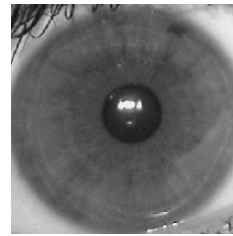


Figure 7. Grayscale image

2.2.2. Remove noise. Digital images obtained often have noise. So before analysing, the image needs to be smoothed with an image filter. This can be done by manipulating neighboring pixels. The filter design makes the image smoother and the angular shape of objects in the image maintained. Noise that occurs in the image is salt and paper. So that this noise can be filtered with the Median filter method. This method replaces the center value of the 3x3 image with the middle value of the sequence value of the 3x3 image.

2.2.3. Image polar to rectangular. The iris which is still in the shape of a circle is converted into a rectangular shape to be taken only in zone 7. The iris shape in the form of a polar can be changed to rectangular form to facilitate the process of taking the analysis area. The process of changing the image to the exposed polar form is shown in Figure 8. Because cholesterol ring is in zone 7, rectangular image is cropped from a distance of 0.89-1. This 300x300 pixel image is converted to an exposed form with a size of 100x614 pixels. The cropped image is shown in Figure 9.

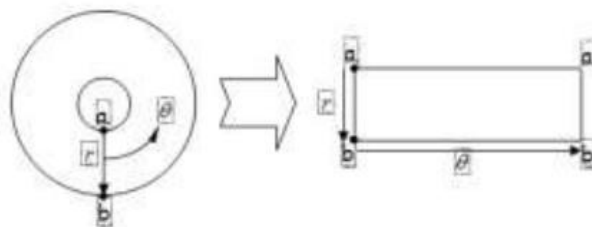


Figure 8. Polar to rectangular form process



Figure 9. Zone 7 of iris with size 100x614 pixels

2.2.4. Region of interest. The iris is sometimes partially covered by eyelids and eyelashes. So that it will reduce the accuracy in processing the image. To avoid this, the image is cropped with size 100 x 153 pixel. The cropped image is shown in Figure 10.

2.2.5. Smoothing image. The method used is Gaussian filter. The ridge structure and noise in image can be reduced by using Gaussian filter. This method will make the image blur so the image becomes smooth. The smoothed image is shown in Figure 11.



Figure 10. Cropped image



Figure 11. Smoothed image

2.3. Feature extraction

The texture comparison method used is the GLCM method [5]. GLCM is a second-order statistical method that calculates the frequency of pairs of pixels that have the same gray level in an image and applies the results obtained using spatial pixels. GLCM provides information on threshold values to be analyzed [6]. GLCM will produce new matrices by calculating the possible values of neighboring pixels. The matrix formed amounted to 4 with angles 0, 45, 90, and 135 degrees and with a pixel distance = 2. The next step is to calculate the average statistical data. The averages calculated of statistical data are energy, homogeneity, correlation, and contrast data [7]. Energy shows the size of the image property of homogeneity. Contrast shows the size of the distribution (moment of inertia) of the elements of the image matrix. Correlation selects the linear size of the gray striped image so that it can provide guidance for the linear structure in the image. Homogeneity indicates the degree of homogeneity of the image displayed in gray. The results of this calculation will be input data to be tested with training data.

2.4. Classification

Classification is used to provide a decision between the normal and abnormal circumstances of a data input. The classification method used is backpropagation neural network. There are two stages to this method, they are training and testing. The training stages of this method are calculating the output of each layer (Z_j and Y_k), calculating the error value (ϵ), and updating the weight and bias (W_{jk} and V_{ik}). The calculations will be finished until the iteration is complete or the error value is smaller than the specified value [8][9]. After the iteration is finished, the parameters of the training results are stored in a database [10]. The next step is calculate the test value by calculating the output of each layer (Z_j and Y_k). From the results of the calculation, it will produce test values which will then be categorized to the type of iris normal or high cholesterol in accordance with the given threshold value. The threshold value obtained is the middle value of the high cholesterol test value with the normal cholesterol test value.

3. Simulation Results

The test was carried out using 30 training images (10 cholesterol and 20 normal). Image training is given a value of 0 for the category of high cholesterol and a value of 1 for normal cholesterol. The determined threshold value of this image processing is 0.5. The value is the median of target value. The data statistics of training images are shown in Table 1.

Table 1. Data statistics of training images

File name	Cholesterol level	Contrast	Correlation	Energy	Homogeneity	Target
k_1.jpg	High	0.3495	0.9840	0.0558	0.8536	0
k_2.jpg	High	0.2158	0.9896	0.0838	0.8921	0
k_3.jpg	High	0.3014	0.9878	0.0729	0.8651	0
k_4.jpg	High	0.2913	0.9866	0.0606	0.8555	0
k_5.jpg	High	0.2606	0.9871	0.0712	0.8702	0
k_6.jpg	High	0.2961	0.9846	0.0584	0.8539	0
k_7.jpg	High	0.2177	0.9936	0.0695	0.8943	0
k_8.jpg	High	0.3981	0.9769	0.0511	0.8241	0
k_9.jpg	High	0.2855	0.9875	0.0600	0.8636	0
k_10.jpg	High	0.2149	0.9933	0.0860	0.8935	0
n_1.jpg	Normal	0.4632	0.9623	0.0606	0.8049	1
n_2.jpg	Normal	0.2957	0.9677	0.1074	0.8605	1
n_3.jpg	Normal	0.1548	0.9921	0.1214	0.9226	1
n_4.jpg	Normal	0.2764	0.9826	0.0711	0.8627	1
n_5.jpg	Normal	0.1770	0.9893	0.1193	0.9126	1
n_6.jpg	Normal	0.2057	0.9834	0.1483	0.8974	1
n_7.jpg	Normal	0.3890	0.9715	0.0697	0.8227	1
n_8.jpg	Normal	0.2877	0.9829	0.0868	0.8581	1
n_9.jpg	Normal	0.2186	0.9836	0.1067	0.8909	1
n_10.jpg	Normal	0.3006	0.9788	0.0736	0.8513	1
n_11.jpg	Normal	0.3437	0.9785	0.0613	0.8341	1
n_12.jpg	Normal	0.8638	0.9549	0.0322	0.7128	1
n_13.jpg	Normal	0.3125	0.9805	0.0625	0.8473	1
n_14.jpg	Normal	0.3301	0.9756	0.0887	0.8395	1
n_15.jpg	Normal	0.1878	0.9785	0.1593	0.9064	1
n_16.jpg	Normal	0.3499	0.9845	0.0705	0.8349	1
n_17.jpg	Normal	0.2333	0.9856	0.0803	0.8855	1
n_18.jpg	Normal	0.3660	0.9782	0.0580	0.8272	1
n_19.jpg	Normal	0.4570	0.9728	0.0558	0.8055	1
n_20.jpg	Normal	0.2293	0.9767	0.1230	0.8868	1

The statistical data and target values in Table 1 are used to become data input for training process. After the training process is complete, testing on the training image can be done. The image training test results are shown in Table 2.

Table 2. Testing value on image training

File name	Testing value	Indicate cholesterol level	Result
k_1.jpg	-0.2776	High	True
k_2.jpg	0.3329	High	True
k_3.jpg	0.1109	High	True
k_4.jpg	0.1266	High	True
k_5.jpg	0.3170	High	True
k_6.jpg	0.2864	High	True
k_7.jpg	-0.3336	High	True
k_8.jpg	0.6591	Normal	False
k_9.jpg	-0.1567	High	True
k_10.jpg	0.1564	High	True
n_1.jpg	0.9263	Normal	True
n_2.jpg	0.9919	Normal	True
n_3.jpg	0.8749	Normal	True
n_4.jpg	0.7580	Normal	True
n_5.jpg	0.8826	Normal	True
n_6.jpg	0.9931	Normal	True
n_7.jpg	0.9629	Normal	True
n_8.jpg	0.8935	Normal	True
n_9.jpg	0.9336	Normal	True
n_10.jpg	0.9264	Normal	True
n_11.jpg	0.8652	Normal	True
n_12.jpg	0.9309	Normal	True
n_13.jpg	0.7810	Normal	True
n_14.jpg	0.9813	Normal	True
n_15.jpg	0.9974	Normal	True
n_16.jpg	0.6454	Normal	True
n_17.jpg	0.5976	Normal	True
n_18.jpg	0.8309	Normal	True
n_19.jpg	0.8460	Normal	True
n_20.jpg	0.9906	Normal	True

4. Conclusions

The combination of Gray Level Co-Occurance Matrix and Backpropagation Neural Network methods in detecting cholesterol levels is able to provide high accuracy results. Based on the results of experiments with 30 training images, the program is able to classify as many as 29 of the 30 data correctly, there was an accuracy rate of 96.67%.

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