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Expert System of Cholesterol Detection Based on Iris Using the Gabor Filter

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Abstract —Cholesterol is a systemic disease. Many complications of its could affect other organs due to uncontrolled cholesterol / fat in the blood. One of them is coronary heart disease. One way to recognize someone having cholesterol is through the eyes. By using the Iridology method, cholesterol disease in a person's body can be detected or seen through the iris of the eye. Checking cholesterol-related conditions is usually done in a hospital or pharmacy. But the problem is that people are still lazy to check their cholesterol. Therefore, we need a software that can make it easier for people to do cholesterol checks. This device will detect cholesterol by using image processing techniques through the iris image accompanied by the Gabor Filter method. From 15 tested data, 13 iris image images were successfully identified, so that the percentage of success of this program was 86%.with 35 trained data.

Keywords : *cholesterol, iris image, image processing, iridology, Gabor Filter*

I. INTRODUCTION

Cholesterol is a systemic disease. Many complications of the disease can affect other organs due to uncontrolled cholesterol / fat in the blood. One of them is coronary heart disease. According to a WHO report in 2011, it was estimated that around 35 percent of Indonesia's population had cholesterol levels higher than the normal limit which is good for health (Sasongko, 2018). Cholesterol itself is defined as one of the components of fat found in food and the body.

One way to recognize someone having cholesterol is through the eyes. The eye is one of the five senses that have an important role in human life. In the anatomy of the eye there is one part called the iris of the eye, this part functions as controlling the amount of light received by the eye. Iris eye is able to describe the condition of a person's body, whether he has a disease or not, including cholesterol disease. Someone who has cholesterol has a dark white circle on the outside of the iris bordering the sclera. By using the iridology method, cholesterol disease in a person's body can be detected or seen through the iris of the eye.

Checking cholesterol-related conditions is usually done in a hospital or pharmacy. But the problem is that people are still lazy to check their cholesterol. Therefore, we need a software that can make it easier for people to do cholesterol checks. This device will detect cholesterol by using image processing techniques through the iris image accompanied by the Gabor method.

II. RESEARCH METHOD

A. Image Processing

Image processing is one method of image processing with input in the form of images. This image will be transformed into another image as the output with certain techniques. The purpose of image processing is to improve the information in

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the image so that it is easy to read or improve the quality of the image itself.

B. Work Procedures

the steps in solving the problem that will be discussed are shown through the workflow that can be seen through the image below, namely:

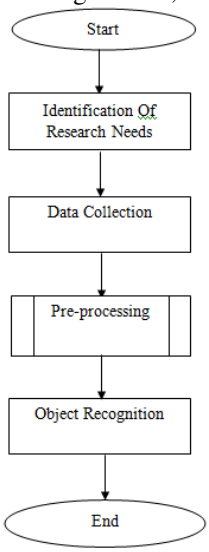

Figure 1. Research Flow

C. Pre-Processing

At this stage, the iris image enters the pre-processing process, the aim is to get a good image and is suitable for the object recognition process. And the steps to process data are as follows:

a. Crop or Image Resize
   Before the iris is recognized, the first thing to do is to crop and image resize. Image resizing is done to equalize the resolution or horizontal and vertical size of the iris image and crop is done to get an iris image without the eyelid
b. Grayscale
   After doing the crop and image resize stages, the next thing to do is the conversion from an RGB image to a grayscale image.
c. Segmentation
   After going through the stage of image resizing and conversion into grayscale images, the next step is to do the image segmentation process where this process separates the object from the background.
d. Feature Extraction
   At this stage, the process of taking the characteristics of the iris image depicts the characteristics of the iris image.

D. Object Recognition

So that an image can be identified based on an existing database, object recognition methods are used. And in this study the object recognition method used is the gabor filter method. The purpose of the gabor filter itself is to bring out the special features of an image by conducting convolution.
The filter used in this study is a 2D Gabor filter kernel. Modulating 2D waves at specific orientations and at frequencies with a Gaussian envelope will produce a 2D kernel gabor filter. Gabor filters use the equation function formula, which is:

$$f(x, y, \theta, \lambda) = \exp\left[-\frac{1}{2}\left\{\frac{x\cos\theta_k + y\sin\theta_k}{\delta_x^2}\right\} + \left\{\frac{-x\sin\theta_k + y\cos\theta_k}{\delta_y^2}\right\}\right] * \exp\left\{\frac{2\pi(x\cos\theta_k + y\sin\theta_k)}{\lambda}\right\} \quad (2.1)$$

Where :

δ_x = standard deviation of Gaussian envelopes on the x dimension

δ_y = standard deviation of Gaussian envelopes on the y dimension

$\boldsymbol{\lambda}$ = 2D sine wavelength

θ_k= 2D sine wave orientation

The image stored in the database will be convoluted first with the image that will be identified using the gabor filter. Convolution of both images will produce points called gabor jet response. Gabor jet response points generated from the convolution of two images will be compared using graph matching on the image to be identified. The matching graph uses the equation, which is:

$$\max_{\forall J} S(J, J') \quad (2.2)$$

Where :

J = Gabor jet model of the database image

J' = Gabor jet model of the image to be identified

And the equation of the similarity function S (J, J ') is defined by the formula below, which is:

$$S(J, J') = \frac{\sum_j a_j a_{j'}}{\sqrt{\sum_j a_j^2 a_{j'}^2}} \quad (2.3)$$

where

a_j = response point of the Gabor Jet model of database images

$a_{j'}$ = the response point of the gabor jet model image that will be identified

E. Cholesterol

Cholesterol is a fat that is useful for the human body. But if the levels in the body are too high, cholesterol will have a negative impact on the body, one of which disrupts blood flow due to the buildup in blood vessels. Cholesterol can be observed through the iris with the help of iridological techniques, cholesterol in the eye is characterized

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by the presence of white circles / rings found on the iris. The thicker white ring indicates the higher level of cholesterol a person has (Kumar etal, 2016).

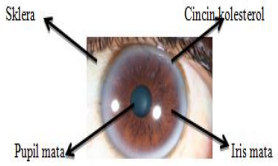

Figure 2. Eye Parts

a. Cholesterol Indicator

Cholesterol is said to be normal if the level is below 200 mg / dL, and high if the level is above 240 mg / dL. Next is the separation of class or cholesterol level[16].

TABLE 1. LEVEL CHOLESTEROL

Cholesterol Level	Condition
Under 200	Low
200-239	Highest Normal Limit
Above 240	High

The cholesterol indicator or level can be seen in Figure 3 below.

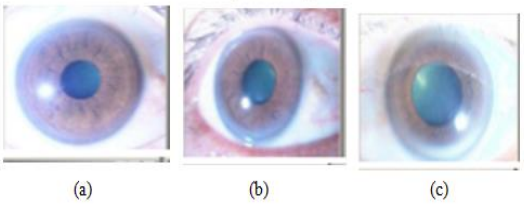

Figure 3. Eye Image (a)Low, (b)Medium, (c)High

III. RESULTS AND ANALYSIS

A. Implementation

The process of detecting cholesterol based on iris is divided into two main stages, the first is the pre-processing stage and the second is the process of detection by feature extraction using the Gabor Filter algorithm. Overall the process scheme can be seen in Figure 4.

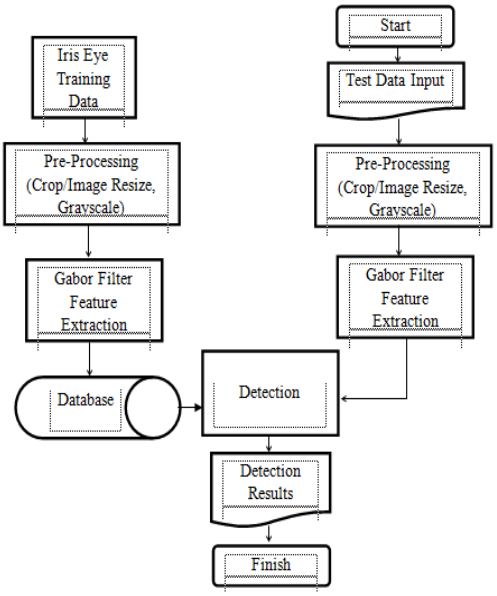

Figure 4. Process Scheme

a. Prepare training data and test data

At the training data stage, there are 35 images of the iris image trained, these data represent each level of cholesterol, ranging from low cholesterol (stage 1), moderate cholesterol (stage 2), and high cholesterol (stage 3). For the test phase, 15 eye images were tested. The following is an example of an iris image

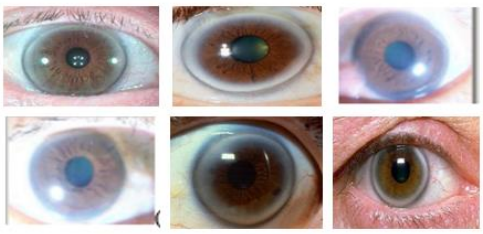

Figure 5. (Top) Data Training, (Bottom) Data Test

b. *Preprocessing*

At this stage, there are 2 processes that are carried out before entering the feature extraction stage, namely the cropping / image resize process and the grayscale process.

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Figure 6. Result *Cropping*

Figure 7. Result Grayscale

c. Feature Extraction with Gabor Filter

This process aims to take the characteristics of the iris image of the eye to get the characteristics of a normal eye and eyes that have cholesterol.

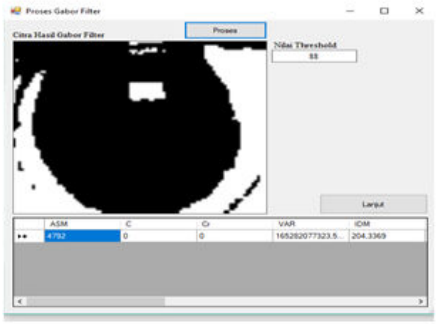

Figure 8. Feature Extraction Result

d. Detection Result

After the input image extracted with Gabor is finished, then the input image will then be matched with the pattern image that has been trained or stored in a database. And the results are shown in the picture below.

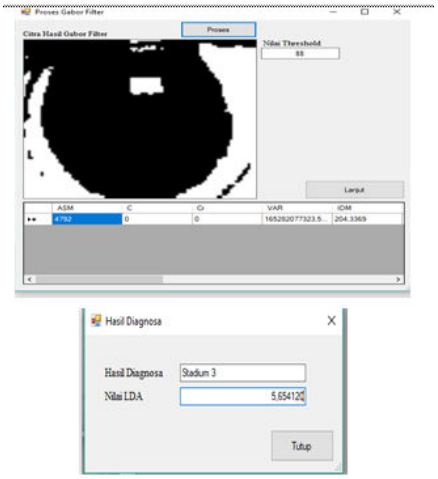

Figure 9. Detection Result

B. Analysis

The detection process was carried out on 35 training data and 15 tested data, the testing process was carried out on 5 eye levels, namely normal eyes, low cholesterol eyes, moderate cholesterol eyes, high cholesterol eyes, and critical cholesterol eyes.

a. Test results with Otsu Threshold values

The results of testing on training and test data using the otsu threshold value can be seen in Table 2 below.

TABLE 2. TRAINING IMAGE RESULTS

No	Data Training	Citra Gambar	Nilai Otsu Threshold	Level Kolesterol
1	irismata1		83	Rendah/Normal
2	irismata2		85	Rendah/Normal
3	irismata3		84	Rendah/Normal
4	irismata4		86	Rendah/Normal
5	irismata5		113	Sedang
6	irismata6		107	Sedang
7	irismata7		116	Sedang
8	irismata8		160	Tinggi/Kritis
9	irismata9		168	Tinggi/Kritis
10	irismata10		157	Tinggi/Kritis

From Table 1 above, the maximum threshold value is 168 and the minimum threshold value is 83 with an average of 115.9

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TABLE 2. TRAINING IMAGE RESULTS

No	Data Training	Citra Gambar	Nilai Otsu Threshold	Keluaran yang diharapkan	Keluaran yang dihasilkan
1	irismatauji1		83	Normal	Normal
2	irismatauji2		85	Normal	Normal
3	irismatauji3		84	Normal	Normal
4	irismatauji4		86	Normal	Normal
5	irismatauji5		113	Normal	Sedang
6	irismatauji6		107	Normal	Sedang
7	irismatauji7		116	Sedang	Sedang
8	irismatauji8		160	Tinggi	Tinggi
9	irismatauji9		168	Tinggi	Tinggi
10	irismatauji10		157	Tinggi	Tinggi
11	irismatauji11		107	Sedang	Sedang
12	irismatauji12		116	Sedang	Sedang
13	irismatauji13		160	Tinggi	Tinggi
14	irismatauji14		168	Tinggi	Tinggi
15	irismatauji15		157	Tinggi	Tinggi

From the results of testing on the 15 iris images above, there were 4 iris images with low cholesterol conditions, 4 iris images with moderate cholesterol condition, and 6 iris images with high cholesterol conditions. In the table above we get 13 iris images whose output matches the expected results so that 13 of these images are said to be true or successful, and 2 other images are considered wrong or unsuccessful. From the above table, it can be analyzed and known the success rate of cholesterol disease detection program through iris. This program is able to carry out the classification process of 13 data from 15 test data, so the percentage of success of this program is 86%, and the calculation is as follows:

The amount of data detected = 13 iris images
The amount of data detected = 15 images
Percentage of success = 13/15 × 100% = 86%

IV. CONCLUSIONS AND RECOMMENDATIONS

A. Conclusions

From the results of research that has been carried out starting from the initial stage to the testing stage, the cholesterol disease detection program through the iris of the eye obtained the following conclusions:

a. The Gabor method can be implemented to extract features of cholesterol disease through iris images.
b. From 15 tested data, 13 iris image data were identified, so that the percentage of success of this program was 86%.
c. Identification of cholesterol is influenced by the number of databases from the data trained to be balanced or reproduced for each level, normal, low, high, and critical.
d. Identification of cholesterol is influenced by the type of image used and the pre-processing stage that is sufficient to be made into data that is easily processed both for training data and test data.

B. Recommendations

Based on the results of the analysis, discussion of the results, and conclusions above, the author can provide suggestions as follows:

a. Data transferred to the database can be reproduced to improve the accuracy of image output.
b. Pattern matching methods can be developed or combined so that when detecting the results obtained are better.
c. Adding Brightness and Contrast to the pre-processing stage and to the testing stage to reduce noise in the cropped image.

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