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IDENTIFICATION OF CORONARY ARTERY DISEASE THROUGH IRIS BY USING CONVOLUTION NEURAL NETWORKS

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ABSTRACT

Now-a-days, coronary heart disease is one of the deadliest diseases in the world. An unfavorable lifestyle, lack of physical activity, and consuming tobacco are the causes of coronary heart disease aside from genetic inheritance. Sometimes the patient does not know whether he has abnormalities in heart function or not. Therefore, this study proposes a system that can detect heart abnormalities through the iris, known as the Iridology method. The system is designed automatically in the iris detection to the classification results. Feature extraction using five characteristics is applied to the Gray Level Co-occurrence Matrix (GLCM) method. The classification process uses the Convolutional Neural Networks (CNN) with linear kernel, to obtain the best accuracy in the system. From the system simulation results, the use of CNN classification of iris conditions with an accuracy rate of 98-99%. This study has succeeded in detecting heart conditions through the iris by dividing the iris into normal iris and abnormal iris.

Keywords— **Iris; Iridology; Coronary heart; Circle Hough Transform; Gray Level Co-occurrence Matrix; Convolutional Neural Networks.**

I. INTRODUCTION

Coronary Artery Disease is the number one cause of death worldwide. According to data from the World Health Organization (WHO), there are 17 million people in the world who die from coronary artery disease. In Indonesia, coronary heart disease is the highest cause of death after stroke, with mortality rate of 12.9% in 2014. Every year there are 1.9 million people die of coronary heart disease due to consuming tobacco. An unhealthy lifestyle and lack of physical activity are the leading causes of coronary heart disease. The death rate is higher among the older age population. Consuming foods high in carbohydrates or fat and obesity are factors that cause constriction of blood vessels in the heart.Examination to determine coronary heart disease will be advised by checking with an Electrocardiogram (EKG), which uses electricity to determine heart rhythm. The use of echocardiography is also sometimes done to see the part, pump function, and valve function of the heart. Taking some actions to check the current heart condition costs quite a bit so that a person will be reluctant to examine his heart condition.Early prevention can be done to reduce the risk of coronary heart disease, namely by consuming enough fruits and vegetables every day, exercising or doing physical activities regularly in daily life, and do not consume tobacco.Nowadays, technology to detect heart conditions from an early stage has been carried out by scientists in the medical field and computing technology. One of them is knowing the heart condition through the eye's iris, which is directly connected to the brain. The brain is a human organ that receives 15% of blood flow from the heart and accounts for 20% of oxygen consumption in the body, making it susceptible to vascularization in the human brain.The iris is one of the unique organs in the human body. Iris is usually used as electronic security or biometric identification system. Nowadays, the research on the iris in the medical field is increasingly widespread and is being seriously studied by experts. Iris can provide information about the condition of human organs, known as the Iridology method.

II. coronary artery disease

Coronary Artery Disease often referred to as **atherosclerosis**, effects the vessels that supply blood to the heart muscle. It is caused by deposits of calcium, fat, cholesterol and fibrous tissues, which makes the lumen of arteries narrower.

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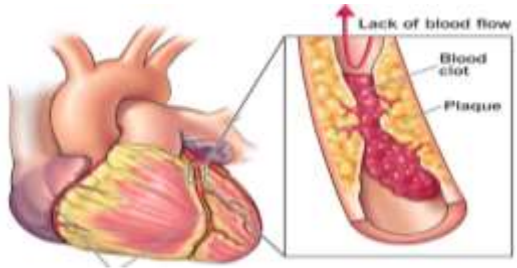

Fig 1: Showing the coronary artery disease

Now-a-days, technology to detect heart conditions from an early stage has been carried out by scientists in the medical field and computing technology. One of them is knowing the heart condition through the eye's iris which is directly connected to the brain. The brain is a human organ that receives 15% of blood flow from the heart and accounts for 20% of oxygen consumption in the body, making it susceptible to vascularization in the human brain. The iris is one of the unique organs in the human body. It can provide information about the condition of human organs, known as the Iridology method. Iridology is based on the analysis of the most complex tissue structures contained in the body. This method can determine the condition of organs and systems in the body. Iridology cannot diagnose a disease but instead helps to identify existing or any potential problems in a particular organ.

III. RESEARCH METHOD

Image Acquisition

In image processing, image acquisition is an action of retrieving an image from an external source for further processing.It could be as simple as being given an image that is already in digital form. Generally, the image acquisition stage involves processing such as scaling and color conversion (RGB to Gray or vice-versa). The image acquisition process consists of three steps: Energy reflected from the thing of interest. An optical system that focuses the energy and eventually a sensor that measures the quantity of energy.

A.Iridology

Iridology is known as a diagnostic method using the human iris. In the medical world, the iris can interpret the condition of human organs. Iridology divides the iris into 60 parts, and each part represents the condition or function of its organs. The right iris will reflect the condition of the right organs of the body, and vice versa, whereas the left iris will reflect the condition of the left organs. Dr. Bernard Jensen has created a chart that describes each part of the 60 sectors in an image that is mirrored in a circular image like a clock and is divided into sectors according to the part of the iris that reflects the organ. The chart has been described according to the division in the left eye and right eye. We can see in Fig.5.2 the position of the heart is on the left side of the iris. The location of the heart is reflected through the left iris, which is shown in the iris zone 02.00 – 03.15.

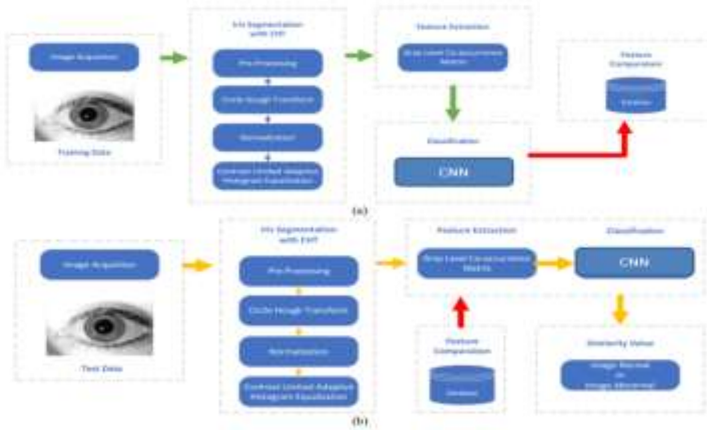

Fig. 2. Shows the Flow of the Designed System; a) the flow of Training System; b) Test Flow System.

B. Pre-Processing

The image captured through a digital camera has an RGB (Red, Green, Blue) format, so it is necessary to do a pre-processing process. In the preprocessing the iris image will be converted from an RGB image to a Greyscale image. The resized image will be processed into the CHT method to obtain the iris and eliminate the pupil area. Grayscale images have a simpler color value with a color intensity of 0 – 255 pixels thus shortening the computation time.

Fig 3: Image pre-processing process

it enters the extraction process. Fig. 3 shows the pre-processing chart. The resized image will be processed into the CHT method to obtain the iris and eliminate the pupil area.

C. Circle Hough Transform

Images that have gone through the RGB to Grayscale conversion process will be separated between the iris and other objects that are not used, especially the pupil. The CHT method is used to determine the iris part automatically without human assistance in determining the coordinates of the iris. CHT can detect circles in the iris image and know between the outer iris and the outer pupil.

$$(x - a)^2 + (y - b)^2 = r^2 \qquad (1)$$

Equation 1 describes the center circle (a, b) and has a radius of r. With (x, y) is a pixel at the edge of the circle, en it can be represented in the form of a circle.

$$X = a + r \cos \theta$$
$$Y = b + r \sin \theta \qquad (2)$$

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Fig.5 describes the CHT method that is implemented into the iris image. The iris image at point (a) has RGB format, which needs to be converted into a greyscale format. The histogram in the grayscale image shows high values in several white areas of objects that occur from light reflections and black colors that have values from the middle pupil of the iris.

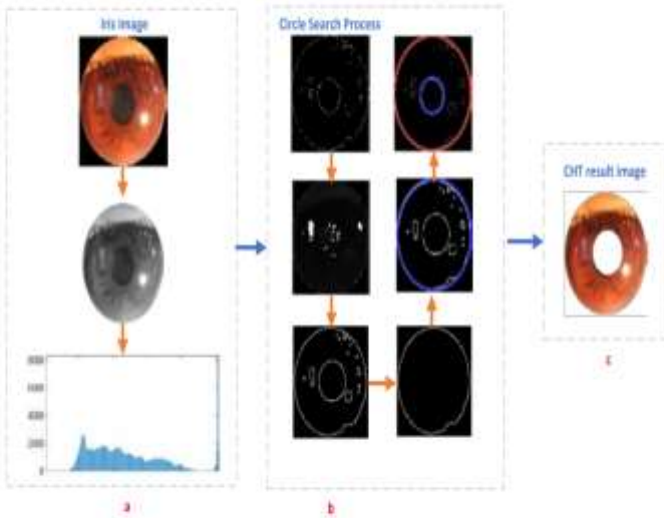

Fig 4: CHT process in detecting circles on the Iris

Then the image at point b is an image display in determining the point of the circumference of the pupil and iris ring. If a part of the noise is not circular in this process, it will be removed. The image is then given a thickening process on the line to determine the circle in the image. Furthermore, the part that has been detected as a circle will be combined with the initial RGB image and generate an image like point c. The CHT algorithm is used to separate the iris from the pupil and sclera. This automatic determination is carried out using edge detection in the form of a circle with a diameter value to determine the inner circle and outer circle of the iris. Edge detection is carried out to find objects with a diameter of less than 3 mm for the object removal process. Then the system will detect a circle with a diameter of more than 3 mm with a shape close to a perfect circle that is selected as the inner iris circle. In determining the outline of the outer iris circle, the system looks for the diameter of the circle measuring 12 mm. Determination of the diameter of the circle is adjusted to the process of taking pictures using constant light so that the images in each data taken to have the same size.

D. Normalization

The texture in the image has coordinates that represent the dimensions of the iris image, such as pupil dilation. The iris image segmentation method aims to normalize the image in a different form but still has the exact resolution. The iris can be modeled by two non-concentric circles and different textures within an iris circle. The center of the pupil can be used as a reference point for the circle on the iris. A radial line runs through the area in the iris, known as radial resolution. Since the pupil is elastic to the iris, it is necessary to rescaling the reference point. The scaling equation is calculated based on the angle around the iris circle with the equation:

$$r' = \sqrt{a\beta^2 - a - r_I^2} + \sqrt{a\beta} \tag{3}$$

where,

$$a = o_x^2 + o_y^2 \tag{4}$$

$$\beta = \cos\left(\pi - arc\tan\left(\frac{o_y}{o_x}\right) - \theta\right) \tag{5}$$

r' is the distance between the pupil and the iris, while θ is the edge angle based on the radius of the iris. o_x and o_y is the displacement from the center of the pupil to the c Iris image that has a circular shape needs to be normalized based on the angle. circular iris will be formed into a 2D array with horizontal dimensions at angles and vertical dimensions at radial so that it will produce a rectangular or polar image shape.

E. Contrast Limited Adaptive Histogram Equation (CLAHE)-CLAHE is a method to improve image quality by limiting the histogram value. In this study, the CLAHE method is used to increase image intensity so that there will be a lot of detail that can be improved on the image. The results of using CLAHE are shown in Fig. 5.

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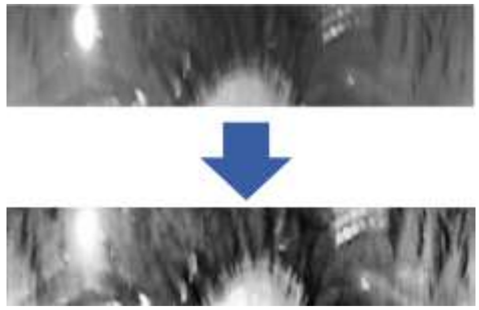

Fig 5: Results of using CLAHE method on Iris Image

F. Region Of Interest

The process of diagnosing the heart through the iris requires certain parts so that it does not require the whole to be processed. According to Iridology, the iris that reflects the heart is on the left iris, as shown in the sector 02.00 – 03.15 according to Fig.8 Region of Interest (ROI) is a process where we only need a specific part of the image to be processed. These sections will be cropped, leaving only the heart's reflection in the iris of the left, as shown in Fig.6.

Fig 6: Application of ROI of the Heart on the Iris Image.

G. Gray Level Co-occurrence Matrix (GLCM)

GLCM is a texture analysis technique on images with a gray level. GLCM has a relationship between 2 neighboring pixels, which is determined by the intensity of gray, a certain distance, and angle. The equation for GLCM is shown below:

$$G_{(\Delta x,\Delta y)}(a,b)=\sum_{i=1}^{P}\sum_{j=1}^{Q}1\{I(i,j)=a\}\ and\ 1\{I(+\Delta x,j+\Delta y)=b\} \quad (6)$$

$I\ (i,j)$ is the gray value of the column (i) and row (j) pixels, (a,b) is a gray value that occurs at the same time as the calculation of $G_{(\Delta x,\Delta y)}(a,b)$. Then, $1\{I(+\Delta x, j+\Delta y)=b\}$ is the indicator of Δx as a direction from x and Δy as a direction of y which is determined by the distance of the x and y. P and Q shows the rows and columns of the corresponding image. There are 4 angles used in GLCM, 0˚, 45˚, 90˚ and 135˚, described in Fig.8. The illustration in Fig.8 is the use of GLCM for image pixels. Point a shows the use of distances that have a value of $d = 1$ with 4 different directions where d is the distance between pixels. Point b shows the GLCM Usage calculation on an image with $\theta = 0^{\circ}$ and the distance between pixels is 1. The image that has been calculated for certain distances and angles will then be transposed to the values obtained, and then the GLCM matrix values are added to the transpose equation:

$$GLCM_{Norm}=\frac{GLCM_{Value}}{\sum_{i}^{N}GLCM_{Value}}$$

Where, $GLCMValue$ = value of each pixel. The normalization results can be used to determine the texture characteristics of the image by obtaining information, such as Contrast, Dissimilarity, Homogeneity, Angular Second Moment (ASM), Energy, and Correlation.

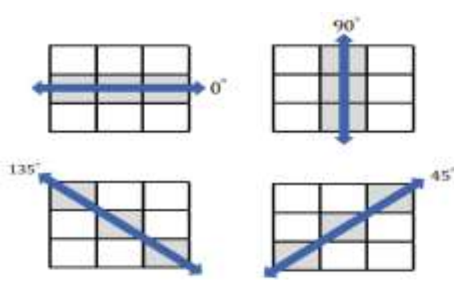

Fig 7. Illustration of 4-Way Angle GLCM.

the difference in intensity between adjacent pixels in the entire image. Dissimilarity is the process of measuring the difference

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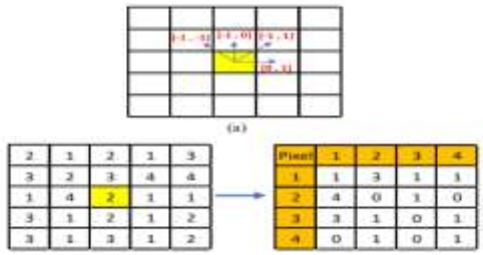
in a texture with a significant value if it is random, and vice versa will have a small value if it is uniform. Homogeneity functions to show the homogeneity of intensity variations in the image. ASM is a uniformity measurement process that produces a high value if the pixel
values are similar to each other and vice versa will have a low value if the pixel values are different. Energy is used to measure the concentration of intensity pairs in the matrix, and Correlation is a linearity measurement of several pixel pairs The equation to obtain each character is shown in table 1.



(b)

FIG 8: GLCM angle illustration a) is an Illustration of the use of θ= 0°, 45°, 90°, 135° dan d = 1; b) GLCM usage calculations for images with θ= 0° and d=1

Texture Characteristics of GLCM	Equation
Contrast	$\sum_{a,b=0}^{level-1} P_{a,b}(a-b)^2$
Dissimilarity	$\sum_{a,b=0}^{level-1} P_{a,b}\lvert a-b\rvert$
Homogeneity	$\sum_{a,b=0}^{level-1} \frac{P_{a,b}}{1+(a-b)^2}$
ASM	$\sum_{a,b=0}^{level-1} P_{a,b}{}^2$
Energy	$\sqrt{\sum_{a,b=0}^{level-1} P_{a,b}{}^2}$
Correlation	$\sum_{a,b=0}^{level-1} P_{a,b}\left[\frac{(a-\mu_a)(b-\mu_b)}{\sqrt{(\sigma_a^2)(\sigma_b^2)}}\right]$ $\mu_a = \sum_a a \sum_b P_{ab}$ $\mu_b = \sum_b b \sum_a P_{ab}$ $\sigma_a^2 = \sum_a (a-\mu_a)^2 \sum_b P_{ab}$ $\sigma_b^2 = \sum_b (b-\mu_b)^2 \sum_a P_{ab}$

Table 1: Characteristic Equations On GLCM

where, a, b = Pixel coordinates on the matrix $level$ = The range of grayscale value between 0-255(level = 256) $P(a, b)$ = value of coordinate pixel (a, b) on matrix GLCM.

H. Convolutional Neural Networks (CNN)

Convolutional neural networks are deep learning algorithms that are very powerful for the analysis of images**.** The architecture of the proposed convolutional neural network (CNN) is a feedforward network that works in a sequential single–input–single–output fashion. For binary classification experimentation, we assume that patients with the presence of CHD will be classified as '1', and others (with CHD absent) will be classified as '0'. An experiment multi-class classification is also performed will be discussed later. As mentioned earlier, the number of active CHD attributes (phenotypes) obtained from the majority voting algorithm is 14. Let us proceed with the assumption that the number of training examples is N, so the input layer indicated in Fig. 1 has an RN×14 dimension. This layer effectively normalizes various variable types before the nonlinear transformation, which is done by the Proposed CNN architecture.

Architecture of CNN

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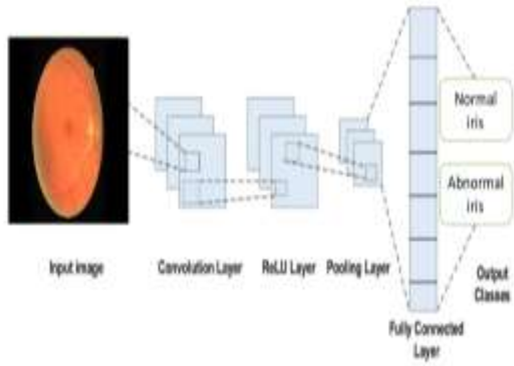

CNN is a powerful algorithm for image processing. These advanced machine learning models have generated equal to and, in some scenarios better results than humans.*Convolution layer*-A convolutional layer is the main building block of a CNN. It contains a set of filters (or kernels), the parameters of which are to be learned throughout the training. A Convolution layer transforms the input image to extract features from it *Rectified Linear unit (RELU) layer*- Rectified Linear Unit (RELU) is the most commonly used activation function in the deep learning. In this layer, we remove every negative value from the filtered image and replace it with zero.*Pooling layer*- Pooling layers are used to reduce the dimensions of the feature maps. The pooling layer summarizes the feature present in a region of the feature map generated by a convolution layer.*Fully connected layer* - The fully connected layer also known as the linear layer connects every input neuron to every output neuron. A neural network in which each neuron applies a linear transformation to the input vector through a weight matrix.*SoftMax layer*- The SoftMax layer is implemented through a neural network just before the output layer. The SoftMax layer must have the number of nodes as the output layer.

IV. Results And Analysis

In this study, system training was carried out using 40 normal iris data and 40 abnormal iris data. Normal iris data is the iris of people who have no history of heart disease; on the contrary for abnormal iris data is the iris of people who have heart disease. In this study, system training was carried out using 40 normal iris data and 40 abnormal iris data. Normal iris data is the iris of people who have no history of heart disease; on the contrary abnormal iris data is the iris of people who have heart disease. The training data uses linear kernel variations. Iris data in training can be separated according to normal (red) and abnormal (blue) classes. The results of linear kernel training separate the data into each class with an even distribution of data. The results of the training can train the machine learning model, which can help in the classification of test data and affect the level of recognition accuracy.

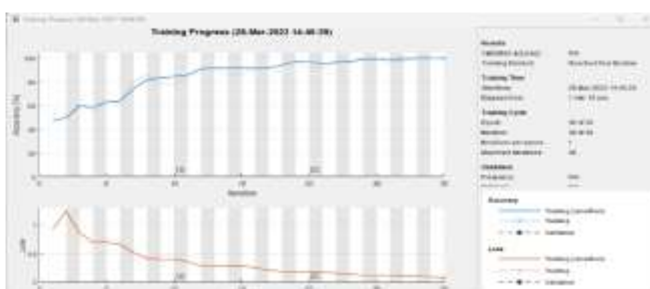

Fig 9. Result of training process accuracy

V. CONCLUSION

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This study has proposed a new method to determine the condition of the heart through the iris using the CNN classification. The use of GLCM characteristics as feature extraction has an essential role in the classification process.
The main contribution in this study is not only limited to determining heart health conditions through the iris but also contributes to the automatic processing of the iris with CHT.

Result Showing Normal and Abnormal Iris

The proposed system for determining the heart condition automatically is to optimize the classification by using angles 0° and 90° on GLCM with CNN classification to obtain a high level of accuracy. In ongoing research, the iris database can be added to improve the classification to make it more accurate

VI. FUTURE SCOPE

In ongoing research, the iris database can be added to improve the classification to make it more accurate. Different extraction methods can be used to get the results of heart condition extraction with a smaller size iris. so that it can increase the system's speed in iris identification.

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