Application Methods Backpropagation in Identification of Functions Kidney Organ by Iris Image

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Abstract*—In the world of medical or health identification early kidney function is something that can not be underestimated. Special attention is needed on this matter. In determining the function of the kidneys can be seen through the internal organs can be seen is the iris. Through iris ophthalmologist can determine a person's kidney function along with several other supporting data. The steps in this research is to analyze the needs, system design, and implementation. In making this program do classification backpropagation in this research is to analyze the needs, system design, and implementation. In making this program do classification backpropagation to classify iris organ normal kidney function normal, acute, and chronic. Someone identified organ normal kidney function when iris regular pattern, while for acute and chronic can be identified if the iris is irregular and had a basin deeper than people who have normal kidney function. The outcome of this study to identify and classify the function of the kidneys by iris of the eye to determine the normal kidney, acute and chronic. Accuracy of this application is to reach 100 percent.

Keywords— health, kidney, eye iris, backpropogation

I. INTRODUCTION

COVID-19 in addition to attacking the lungs, COVID-19 can also attack the kidneys, but many people are unaware, especially Americans. In the 2020 National Kidney Foundation-Harris Poll Survey on COVID-19 and findings on Kidney Health showed very low awareness of the risk of developing acute kidney injury due to COVID-19, in the long-term it has an impact on kidney health. Few of Americans are aware of COVID-19 can cause acute injury to the kidneys, only 1 in 5 people are aware of it. Acute kidney injury (AKI) occurs in about 15% of the total coronavirus patients who have been treated, now many of these patients require dialysis [1].

Kidneys are the organs which must be protected and treated early. So we have to know the science of studying it in order not mistaken in treating kidney. Iridology is scientific knowledge that analyzes the composition of the iris. Iridology is the science that can detect declining kidney function based on the detection edge of the iris of the human eye. It can be used to perform diagnostic guidelines for kidney disease. Advances in science and technology in particular processing digital image could be applied to assist the classification and identification of an object. Image processing technology (Image processing) can be applied to recognize and identify the function of the kidney. One of research has neural networks to identify the Retinoblastoma using algorithms backpropagation by generating value 90% accuracy.

In this study, the authors identify based on some previous research methods Algorithms backpropagtion based backpropagtion a controlled type of training (supervised) using weighting adjustment patterns to achieve the minimum error between the output value of the prediction results with real output [2]. By using the algorithm, it can be expected to facilitate the process of identifying the function of the kidney with good accuracy.

Based on the description above, conducted research entitled "Application Methods Backpropagation in Identification of Functions Kidney Organ by Iris Image".

II. PREVIOUS RESEARCH

Retinoblastoma is eye cancer and it occurs in children. This disease attacks the thin nerve tissue behind the eyes (the part that is sensitive to light). Retinoblastoma attacks one or both eyes of the patient, the disease is a type of disease that can be caused by a genetic mutation called Retinoblastoma1 (RB1). This disease can cause blindness, even cause death.

The method used in this research is Backpropagation Artificial Neural Network using input of the retinal fundus image. Steps in overcoming retinoblastoma are image management (resizing, gray scaling, morphological closure surgery, and optical disk elimination), methods using the backpropagation nervous system and the Co-Gray Level Matrix for feature extraction in the system testing in this study, the method used This use reaches 90% accuracy [3]–[5].

III. LITERATURE REVIEW

3.1 Iris

The iris can be used as the basis of biometric systems. System iris texture is specific and unique to each person as well as stable decades - twenty years, the patterns of the iris are relatively constant over a person's lifetime [6]–[9]. It is sheltered behind the cornea (cornea) make iris protected from damage or external changes. The eye is not able to alter through surgery without causing any damage to eyesight. The figure below shows the anatomy of the eye human:

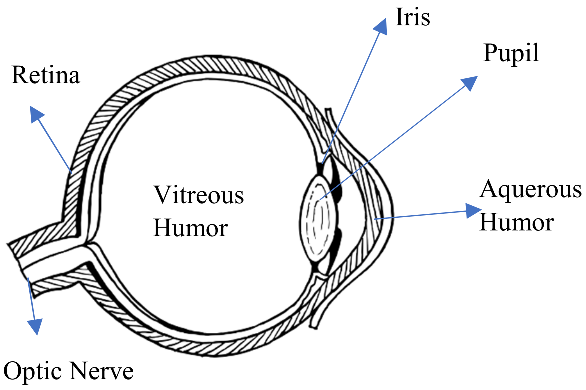


Figure 1. Anatomy of Human Eye

Iris is a protected internal organ in the eye, located behind the cornea, located in front of the lens of the eye. Iris is one - the only organ in the body that can be seen by the human eye normally. Formation of the iris begins during the third month of embryonic life [10].

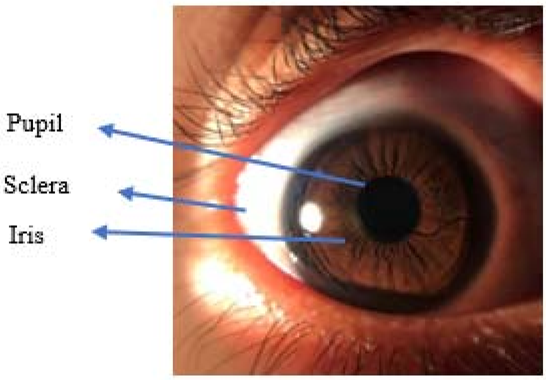


Figure 2. Exterior Eyes

Advantages of the use of iris to system reliable identification is as follows:

a. From the outside iris has isolated and protected.
b. In the eye not possible surgery for modification without cause defects.
c. Iris has a physiological response to which allows natural light testing to the possibility of fraud and the use of fake eye lenses and so forth.

3.2 Iridology

At Iris human eye has a pattern that is very unique and different every human being, so it is possible to use it as a basic introduction biometric known to science Iridology. Iridology is the science that studied the medical examination by the iris of the eye. In iridology there are many aspects to be considered by the researchers as practitioners must determine the color of the iris, structure and special signs such as fiber, belly rings, pigmentation, blanks, fiber, groove, and others. More recently, many researchers have produced a system diagnosis automatic or semi-automatic iris.

3.3 Kidney

Kidney is one organ in man which serves as a filter and dispose of waste, such as toxins, excess salt, and urea (waste containing nitrogen result from protein metabolism). Kidney disease can show symptoms. Chronic kidney disease may not show symptoms until your kidney function is not functioning properly.

Treatment for kidney disease usually affects the development of kidney damage is by controlling the underlying cause. Disease kidney chronic develops into end-stage renal failure, which is fatal without artificial filtering (dialysis) or a kidney transplant. Signs and symptoms of kidney disease develop over time if the kidney damage progresses slowly.

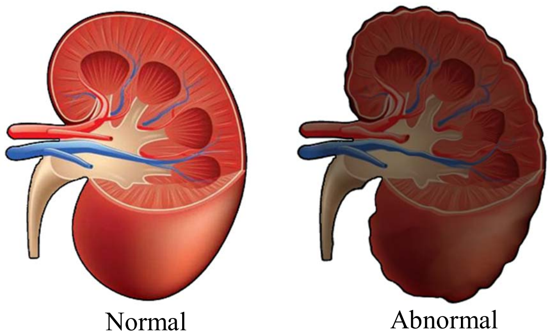


Figure 3. Kidney Normal and Abnormal

3.4 Image Processing

Image processing is a form of processing or signal processing with input the form of pictures (Image) and transformed into another image as output with specific techniques. The output image has better quality than the input image. Eg color image less sharp, blur (blurring), contains noise (white spots), etc. So it needs no processing to improve the image because the image becomes difficult to interpret because the information conveyed is reduced. The image processing aimed at improving the quality of the image to be easily interpreted by humans or machines (in this case the computer). Generally, operations on image processing when applied to the image:

- Improve image quality
- element needs to be measured
- the image needs to be combined with other parts

IV. METHOD

4.1. GLCM

GLCM is one of the statistical methods for texture feature extraction and is among the most widely used in texture analysis techniques. GLCM uses texture statistical calculations in the second order. Cookurence can be said as a joint event, ie an event where one level of gray value of a pixel is next to another level of gray value of another pixel. Let D be defined as the distance between two pixels expressed in pixels, θ is the angular orientation between pixels in degrees, and N is the number of levels of pixel intensity in an image. Then GLCM is a square matrix P [i, j] with dimension N x N, where each element [i, j] states the probability of occurrence of a pixel of intensity i next to another pixel with intensity j, and between the two pixels has a distance of D with angle θ. Angular orientation θ consists of four angular directions with 45° angular intervals, namely 0°, 45°, 90° and 135°

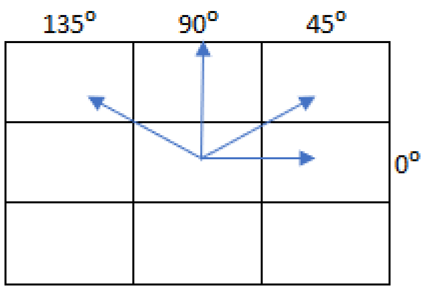


Figure 4. Angular orientation θ

For the sake of illustration, the pixel neighbor can be selected eastward (right). One way to represent this relationship is in the form of (1, 0), 1 for the spatial distance of bicycle and 0 for the angle used, which represents the relationship of two pixels that line horizontally. The illustration above can be illustrated below, from the original image of 2 bits with a size of 3 x 3 pixels paired based on the composition of neighboring pixel pairs, the original image is a 2-bit image so that the composition of pixel pairs is from 0 to 3 (2^2-1). From the kookurensi matrix, we can get 5 texture features which are image representations. These features include:

- Contrast is a measure of the spread of image matrix elements. If it is located far from the main diagonal, the value of contrast is large. To get the contrast value defined in equation, where i and j are rows and columns.

$$Contrast = \sum_i \sum_j (i-j)^2 \, P[i,j]$$

- Correlation (Correlation) states the size of the linear dependence of the degree of gray image so as to provide a clue to the existence of linear structures in the image.

$$Correlation = \frac{\sum_i \sum_j i\, j\, P[i,j] - \mu_i \mu_j}{\sigma_i \sigma_j}$$

- Energy, also called Angular Second Moment, refers to a measure of concentration of a pair with a certain gray intensity on the matrix, where (i, j) expresses the values in row i and column j in the cohesion matrix.

$$ASM(Energy) = \sum_i \sum_j P^2\,[i,j]$$

- Entropy is a measure of the irregular shape of an image. The large entropy value indicates the high structure of the image, the smaller the entropy value, the more varied or random the image is.

$$Entropy = \sum_i \sum_j P\,[i,j] \log P[i,j]$$

- Homogeneity shows the homogeneity of imagery with similar ethnic groups. Homogeneous imagery will have great homogeneity.

$$Homogenity = \sum_i \sum_j \frac{P[i,j]}{1+|i-j|}$$

4.2. Backpropagation Algorithm

Backpropagation constitute algorithm supervised learning and is typically used by perceptron with many layers to change the weights connected to existing neurons in the hidden layer. Backpropagation has excellence making often used in system introduction and creates a pattern. There three phases in the algorithm backpropagation, namely forward propagation phase, hidden layer then output layer. Once the second phase is the propagation backward to find out the errors of the network. The third phase is the phase modification of the weights used to calculate the weight changes that occur in the network. When the stage of forward propagation must be done in advanced to get the value of the error. When advanced propagation of neurons activated by using binary sigmoid activation function algorithm backpropagation use error output to change the values of the weight in the error output to change the values of the weight in the backward direction (backward). Advanced propagation phase (forward propagation) must be done in advance to get the value of the error. When advanced propagation of neurons activated by using binary sigmoid activation function, namely:

$$F(x) = \frac{1}{1+e^{-x}}$$

Neural network architecture backpropagation as shown in the figure below:

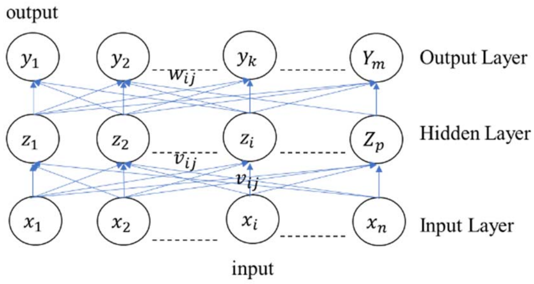


Figure 5. Backpropagation Algorithm

x1 s/d xn: input layer
z1 s/d zp: hidden layer
y1 s/d ym: Output Layer

From the diagram above it can be seen X is the input from the network, Z is hidden layer, Y is the output layer, Vij is the weight of intermediate connecting neurons input with hidden layer, Vlj is the weight reflection for neurons that go to the hidden layer, Wjk is the weight of the connecting neuron between the hidden layer with the output layer, and Wlk is the reflection weight for the neurons that are headed output layer.

Neural network method with backpropagation algorithm as follows:

1. Initialize weights with random values or fairly small random. Arrange learning αas low as possible ($0 < \alpha <= 1$)
2. During the stop condition still not fulfilled, carry out Phases 2 through 9.
3. For each pair of training, do it numbers 4 through 9.

Feedforward

4. Each input (X_i, i = 1,2,3, ... n) receives signal X_i and forward that signal on the hidden layer
5. Each unit is hidden (Zj,j =1,2,3,....p)adding weighted input signals:

$$Z_{in}j = V0_j + \sum_{i=1}^{n} X_i V_{ij}$$

6. Each Output (Yk, k = 1,2,3, ..., m) sums the weighted input signals:

$$Y_{in}k = W0_k + \sum_{i=1}^{p} Z_i W_{jk}$$

the output signal is calculated from the activation function.

$$Y_k = (Y_{in}k)$$

Then the signal is sent to all units in the upper layer (Output units).

Backpropagation error

7. Each Output unit (Y_k k = 1,2,3, ..., m) receives a target pattern related to the Learning Input pattern. Then the error information will be calculated.

$$\sigma_k = (t_k - y_k) f'(Y_{in}k)$$

The weight to be used is the weight calculated after being fixed W_{jk}

$$\Delta W_{jk} = \alpha \times \sigma_k \times z_{ij}$$

Then the correction bias is calculated (which will be used to correct the value of W_{0k}):

$$\Delta W_{0k} = \alpha \times \sigma_k$$

Send this σk to the units on the bottom layer.

8. Each hidden unit (zj, j = 1,2,3, ..., p) adds up the Input delta (from the units in the layer above it):

$$\sigma_{in}j = W0_k + \sum_{k=1}^{m} \sigma_k W_{jk}$$

Then multiply this value by the derivative of the activation function to calculate the error information:

$$\sigma_{in}j = \sigma_{in} j\ f'\ (Z_{in}\ j)$$

then a weight correction is calculated (which will be used to correct the value Vij):

$$\Delta Vjk = \alpha \times \sigma j \times Xi$$

for the value used to correct is the calculation of the bias value $V0j$:

$$\Delta V0j = \alpha \times \sigma j$$

Update weights and biases

9. Each unit of Output (yk, k = 1,2,3, ..., m) fixes its bias and weight (j = 0,1,2,3, ..., p) with the equation.

$$Wjk\ (baru) = Wjk\ (lama) + \Delta Wjk$$

Each hidden unit (zj, j = 1,2,3, ..., p) fixes its bias and weight (i = 0,1,2,3, ..., n) with the equation.

$$V_{ij}\ (baru) = V_{ij}\ (lama) + \Delta V_{ij}$$

10. Stop condition test

If σk <the initial error set value then "Stop Training".

4.3. Flowchart

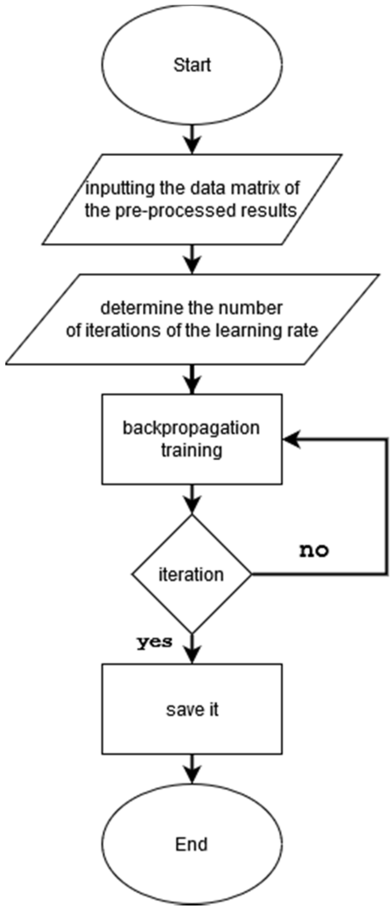


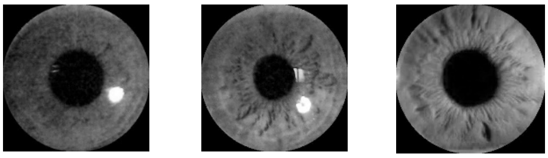
Figure 6. Flowchart of program

The flowchart above illustrates the sequence the process in detail and the relationship between a process (instructions) with other processes in system to be created. The order of the system is will be made.

At the beginning of the application opening inserting images into the pre-processing process, then determined by the amount of literacy for the pace of learning in order to achieve the goal, after that do training backpropagation methods, followed by conditions where if not going back to backpropagation training, if yes then it will be saved and finished.

V. IMPLEMENTATION

The dataset has 3 classification, and it form medical services. Medical services can be a hospital, clinic, or PUSKESMAS (small size of health center owned by the government) [11]. The preprocessing and classification will use the grouped data in this program [12].



Normal Acute Chronic

Figure 3. Sample of the iris dataset

In previous program the network training process done by determining iteration (epoch), learning rate (α), goal desired process. On research this researchers used training data as many as 22 data, the number of iterations as many as 500, at a rate learning 0.01, 0.05, 0.1 because if the pace of learning results too fast or too slow introduction is not good, goal is used by researchers namely 0.01. With the same dataset, the results are obtained introduction to iris image vectors eyes reach a level of accuracy recognition reached 93.75% from the journal with the title "Identification of Reduction Kidney Organ Function Conditions Through Iris Eyes Using Network Methods Neural Artificial Learning Vector Quantization" [13].

In the implementation of the identification system of kidney organ function decline based on color features in the RGB image and GLCM features in the human eye using this backpropagation method the activation function used is the binary sigmoid activation function.

1. Open Image on the storage media
2. Pre-processing the input image, by resizing.
3. Extract color features, by taking RGB values from the input image
4. Normalize the RGB value.

$$Red = \frac{R}{R+G+B}$$

$$Green = \frac{G}{R+G+B}$$

$$Blue = \frac{B}{R+G+B}$$

5. Cropping 128 x128
6. Get value of GLCM

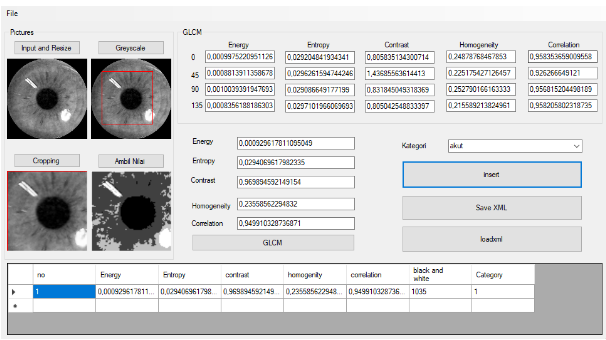


Figure 6. Extraction Form

Extraction feature is done by taking data and the data has been resized, the eyes that have been prepared by changing it to black and white, after that the middle part is taken with a red box with image segmentation is a critical process in many image processing applications such as object detection, shape recognition, and optical character recognition [14]. Segmentation an important role in many image processing application [15]. Most of the latest progress in iris recognition has beenfocused on improving the recognition of non-ideal irides and removed to use the GLCM feature, After obtaining the GLCM feature a number will be obtained to be accepted in XML.

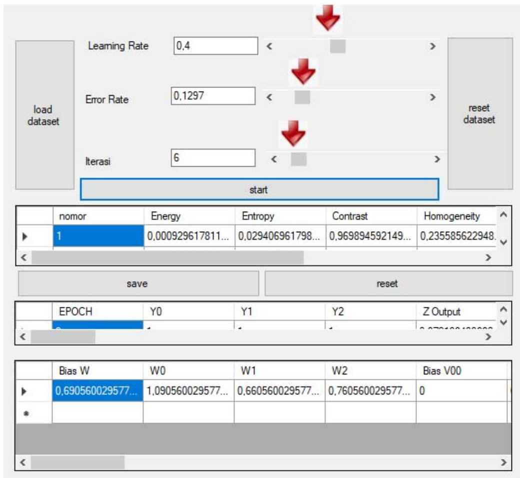


Figure 6. Training Form

First level of initialization learning, the weight of the connecting neurons and the predetermined bias weights. Following are the weights used for backpropagation calculations. Give a value of Learning Rate (LR) and generate initial Bias Weight, and initial Neuron Weight. After the new weight is found, it will be used as the initial weight for the calculation of the second sample data.

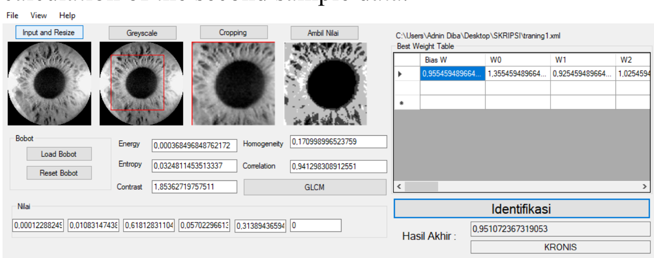


Figure 6. Testing Form

The test is carried out using the value of the tested image compared to the value that has been stored in XML. Accuracy using segmentation algorithm validation based on truth mode[16]. The performance of edge detection techniques are always judged personally and separately,dependent to its application[17].

Table 1. Test Result

Name	Testing	Identification
N1	Normal	Normal
N2	Normal	Normal
N3	Normal	Normal
N4	Normal	Normal

N5	Normal	Normal
A1	Acute	Acute
A2	Acute	Acute
A3	Acute	Acute
A4	Acute	Acute
A5	Acute	Acute
C1	Chronic	Chronic
C2	Chron	Chronic
C3	Chronic	Chronic
C4	Chronic	Chronic
C5	Chronic	Chronic

in 15 testing trials including 5 acute data, 5 acute data, and 5 chronic data and the data tested are all correct.

VI. Conclusions

The system has been built to provide identification of kidney function through the image of the iris. Results In the discussion section and a testing phase to test implementation system design, and features in the kidney organ function identification applications. In this test using 15 samples with 5 normal kidney organ functions, 5 acute kidney, 5 chronic kidney. If the output is more then 0.3 is identified acutely by the system, and above 0.6 are considered chronic. From the tests that have been done previously, the lowest calculation results obtained with a learning rate of 0.1 and iteration / epoch 500 produce an accuracy rate of 50% and the best results are using a learning rate of 0.3 and iteration / epoch of 1000 and produce an accuracy of 100%.

REFERENCES

[1] National Kidney Foundation, "COVID-19 Patients are Becoming Kidney Patients but Most Americans Unaware | National Kidney Foundation," *https://www.kidney.org*, May 14, 2020. https://www.kidney.org/news/covid-19-patients-are-becoming-kidney-patients-most-americans-unaware (accessed Aug. 23, 2020).

[2] D. Wicaksono, E. Firmansyah, and H. A. Nugroho, "A microclimate closed house control design for broiler strain," Oct. 2017, doi: 10.1109/INAES.2017.8068539.

[3] U. Andayani *et al.*, "Identification of Retinoblastoma Using Backpropagation Neural Network," in *Journal of Physics: Conference Series*, Jul. 2019, vol. 1235, no. 1, doi: 10.1088/1742-6596/1235/1/012093.

[4] N. Gupta, G. Garg, and L. Kumar, "Finding Retinoblastoma Cancer Using Image Processing," 2015. [Online]. Available: www.ijarcsse.com.

[5] M. F. Syahputra *et al.*, "Hypertensive retinopathy identification through retinal fundus image using backpropagation neural network," in *Journal of Physics: Conference Series*, Mar. 2018, vol. 978, no. 1, doi: 10.1088/1742-6596/978/1/012106.

[6] "US5291560A - Biometric personal identification system based on iris analysis - Google Patents." https://patents.google.com/patent/US5291560A/en (accessed Aug. 23, 2020).

[7] J. Daugman, "Statistical richness of visual phase information: Update on recognizing persons by iris patterns," *International Journal of Computer Vision*, vol. 45, no. 1. Springer, pp. 25–38, Oct. 2001, doi: 10.1023/A:1012365806338.

[8] J. Daugman, "Demodulation by complex-valued wavelets for stochastic pattern recognition: How iris recognition works," in *Proceedings of the International Conference on Wavelet Analysis and Its Applications (WAA)*, 2003, vol. 2, pp. 511–530, doi: 10.1142/9789812796769_0081.

[9] J. Daugman, "How Iris Recognition Works," *IEEE Trans. CIRCUITS Syst. VIDEO Technol.*, vol. 14, no. 1, 2004, doi: 10.1109/TCSVT.2003.818350.

[10] D. Smerdon, "Anatomy of the eye and orbit," *Curr. Anaesth. Crit. Care*, vol. 11, no. 6, pp. 286–292, Dec. 2000, doi: 10.1054/cacc.2000.0296.

[11] Y. Dian Harja and R. Sarno, "Determine the best option for nearest medical services using Google maps API, Haversine and TOPSIS algorithm," in *2018 International Conference on Information and Communications Technology, ICOIACT 2018*, Apr. 2018, vol. 2018-January, pp. 814–819, doi: 10.1109/ICOIACT.2018.8350709.

[12] "Classification of driver fatigue state based on EEG using Emotiv EPOC+ | Request PDF." https://www.researchgate.net/publication/305417019_Classification_of_driver_fatigue_state_based_on_EEG_using_Emotiv_EPOC (accessed Aug. 23, 2020).

[13] A. P. Putra and T. Sutojo, "Identification of Reduction Kidney Organ Function Conditions Through Iris Eyes Using Network Methods Neural Artificial Learning Vector Quantization," 2014.

[14] J. S. Weszka, "A survey of threshold selection techniques," *Comput. Graph. Image Process.*, vol. 7, no. 2, pp. 259–265, Apr. 1978, doi: 10.1016/0146-664X(78)90116-8.

[15] U. Salamah, R. Sarno, A. Z. Arifin, A. S. Nugroho, I. E. Prayitno Rozi, and P. B. Setia Asih, "Incorporating Index of Fuzziness and Adaptive Thresholding for Image Segmentation," *Int. J. Electr. Comput. Eng.*, vol. 8, no. 4, p. 2406, Aug. 2018, doi: 10.11591/ijece.v8i4.pp2406-2418.

[16] S. K. Warfield, K. H. Zou, and W. M. Wells, "Simultaneous truth and performance level estimation (STAPLE): An algorithm for the validation of image segmentation," *IEEE Trans. Med. Imaging*, vol. 23, no. 7, pp. 903–921, Jul. 2004, doi: 10.1109/TMI.2004.828354.

[17] "(PDF) Edge Detection Techniques For Image Segmentation." https://www.researchgate.net/publication/274872300_Edge_Detection_Techniques_For_Image_Segmentation (accessed Aug. 23, 2020).