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Identification of Malaria Parasite Patterns With Gray Level Co-Occurance Matrix Algorithm (GLCM)

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Abstract

The results of the test using 5 data of malaria parasite test imagery found that image 1 has an average accuracy value of the energy of 0.55627, homogeneity average of 0.8371, PSNR of 6.1336db, and MSE of 0.24358. Image 2 has an average energy accuracy value of 0.22274, an average Homonegity of 0.98532, a PSNR of 6.1336db, and an MSE of 0.24358. Image 3 has an energy average accuracy value of 0.28735, a Homonegity average accuracy value of 0.9793, a PSNR of 6.133db, and an MSE of 0.24358. Image 4 has an energy average accuracy value of 0.32907 and an average homogeneity accuracy value of 0.97073, PSNR 6.133db, and MSE 0.24358. Image 5 has an average accuracy value of 0.74102, Homonegity average of 0.99844, PSNR of 6.133db, and MSE of 0.4358. Image 6 has an accuracy value of 0.34758 energy, an average accuracy value of homogeneity of 0.99129, a PNSR of 6.133db, and an MSE of 0.24358. Obtained the rule if the average value of energy > = 0.50 then the pattern of malaria parasites is very clear, namely Image 1 and image 5 with a pattern of malaria parasites is very clear.

Keywords: Parasites, Malaria, GCLM, Extraction, Patterns, Identification.

1. Introduction

Based on information obtained from the Ministry of Health of the Republic of Indonesia in 2021, that in 2010 positive cases of malaria in Indonesia reached 465.7 thousand, while in 2020 positive cases decreased to 235.7 thousand. Not only that, the decline in malaria cases was also followed by a decrease in Annual Parasite Incidence (API) which in 2010 reached 1.96 and 2020 reached 0.87. Malaria prevention can be done by using mosquito nets, installing gauze wire, not hanging used clothes, using anti-mosquito drugs, and spreading flick-eating fish[1].

Based on information from ANTARA News on June 1, 2021, the Eijkman Institute of Biology said the results of research conducted by Eijkman and colleagues showed that a large number of malaria parasites were hiding in the spleen organ. The study proved that a large number of malaria parasites hide in the human spleen that are actively capable of multiplying in their life cycle. It was a new breakthrough for the understanding of malaria pathogenesis that has never been known before[2].

Based on malaria case data from the Annual Parasite Incicence (API) informed by the kompas.com on April 27, 2021, over the past decade, malaria infection cases in Indonesia have decreased. This was conveyed by the Director of Prevention and Control of Vector and Zoonotic Tular Diseases (P2PTVZ), dr. Drh. Didik Budijanto, M.Kes. "He said that actually our trend is decreasing. If we look from 2010 to the last 2020 yesterday," said Didik, on the You Tube broadcast of the Ministry of Health of the Republic of Indonesia, Friday. Recorded, from the latest data, in 2020, the number of malaria cases was 235,780 cases. However, Didik said that there is a tendency that this number is stagnant[3].

As compiled by beritasatu.com, the World Health Organization (WHO) launched an initiative to help eradicate the deadly malaria in 25 more countries by 2025. As reported by AFP, Wednesday (04/21/2021), WHO said more and more countries are trying to eradicate malaria. Ahead of World Malaria Day on Sunday, the UN health agency confirmed that the elimination of the disease that kills around 400,000 people each year worldwide is a "worthy goal for all countries". Through an initiative launched in 2017, WHO said it had supported 21 countries in an effort to bring the burden of malaria cases to zero by 2020. Eight of the 21 countries reported zero cases of malaria

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in humans at the end of last year, including China, Iran and Paraguay. And the WHO said it has now identified a new group of 25 countries, including some from the previous group and some new additions, with the potential to eradicate malaria within five years, by 2025. Among the countries in the new group are Guatemala, Honduras, North Korea and Thailand. "These countries will receive special support and technical guidance as they work towards the zero malaria target," the WHO said. In its annual report on malaria published last November, the WHO estimated that about 229 million people suffered from the mosquito-borne disease in 2019, the same figure over the past four years. The world health organization (WHO) has recommended the widespread rollout of the world'kompas.com s first malaria vaccine, in a move experts hope could save tens of thousands of children's lives each year across Africa. WHO Director-General Dr. Tedros Adhanom Ghebreyesus said that after successful pilot programs in three African countries, the RTS malaria vaccine should be widely available for a "historic day". The vaccine, through lengthy clinical trials, has limited efficacy. Its use prevented 39 percent of malaria cases and 29 percent of severe malaria cases among young children in Africa during the four-year trial. However, in August a study led by the London School of Hygiene & Tropical Medicine (LSHTM) found that when children were given the RTS,S malaria vaccine and antimalarial drugs, there was a 70 percent reduction in hospitalization or death[4].

Malaria is a parasitic disease caused by blood protozoa of the genus Plasmodium derived from the species P. falciparum, P. vivax, P. ovale, P. malariae, and P. knowlesi. Plasmodium vivax can cause relapse due to the presence of a hypnozoite stage in the liver that can one day develop again[5]. Malaria is a public health problem because it can cause death. Malaria is caused by protozoan parasites of the genus plasmodium. There are five types of plasmodium caused by the Anopheles mosquito: P. falciparum, P. vivax, P. ovale, P. malariae and P. knowlesi[6]. Proper and prompt early diagnosis and accurate therapy are key to minimizing morbidity and mortality due to malaria. Who recommends the management of malaria cases based on parasite-based diagnosis for all cases. Except in children in areas with high transmission and lack of resources or in circumstances where rapid response or action is required so as to temporarily limit their use.

Some previous studies that discuss malaria include research that uses segmentation methods after image processing is very influential on the results of test accuracy. Evidence has been done in this study the use of thresholding + otsu combinations can improve accuracy results. The difference in accuracy value between using the thresholding + otsu combination method with thresholding reaches 43% and 20% when using the thresholding + otsu combination method with the otsu method[7].

Further research found that classification testing obtained an average accuracy rate of 91.11% with a total sample of 105 training data images and 15 test images consisting of 5 trophozoite stage images, 5 skizon stage images, and 5 gametosite stadium images. Classification testing based on cv kfold resulted in an average accuracy of 94.99%. From these results, this system is able to classify the stage of plasmodium falciparum malaria well and can be used as a support system for parasitology doctors.

Furthermore, research using GLCM results in this study will be carried out the process of extracting features of shape and texture to recognize species and phases in malaria disease use. k-means clustering and Naïve bayes classifier for texture features and For shape features using regionprops functions with features to be used include area, centroid, bounding Box, eccentricity, equiv Diameter. The image objects to be used in this study are plasmodium malariae, plasmodium falciparum, plasmodium vivax and plasmodium viva species. Using data of 60 blood preparation images, each 15 images of preparations for each species. The results of the study in Extraction feature texture using GLCM with four parameters and extraction of form features using the function of regionprops with four parameters can not extract the type and phase of malaria parasites well in blood cell objects with its non-homogeneous backgroud[8].

Digital Image Processing (Digital Image Processing) is a discipline that learns about techniques in processing imagery, the image in question is a still image (photo) or a moving image (such as a recorded video). While the meaning of digital is the processing of image / image is done using a computer digitally. RGB stands for Red-Green-Blue, is three basic colors (primary colors) which are generally used as other color references From the RGB base, we can convert colors into number codes that make the color will appear universal. The computer has packed the color information into the same color model so that it makes RGB color processing can be done easily[9].

Therefore, an analysis is needed to identify how to find out the pattern of spreading malaria parasites digitally by using a computer so that it can facilitate and help the problems above. In this study, the authors used digital photos in png, and tif) format derived from digital photos of malaria parasite images from open source websites. The first step is to download the image from the webiste https://www.kaggle.com/datasets/saife245/malaria-parasite-image-malaria-species. Furthermore, the images that have been obtained will be processed using image processing techniques on a computer using image texture analysis approach techniques to find out

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images affected by malaria parasites. Furthermore, all information collected will be tested with matlab tools.

Texture analysis is commonly used as an intermediate process for classifying and interpreting imagery. An image classification process based on texture analysis generally requires a characteristic extraction stage, consisting of three types of methods, namely statistical methods, spactral methods and structural methods. GLCM is a method widely used in research for texture analysis in images introduced by Haralick in 1973. The simple concept of GLCM is that it can calculate a variety of pixels with an intensity called i and the similarity of pixels or j, at the distance or d and orientation from the angle of θ. Basically GLCM is used in 4 specific angular orientations, namely angles 0°, 45°, 90°, and 135[10]. The GLCM (Gray Level Co-occurrence Matrix) method is included in the statistical method where in statistical calculations it uses the distribution of grayish degrees (histograms) by measuring the degree of contrast, granularity, and roughness of an area of the relationship of efficiency between pixels in the image. This statistical paradigm has unlimited use, making it suitable for unstructured natural textures of subtypes and set rules (microstructures). The statistical method consists of the extraction of first-order traits and the extraction of second-order traits. The extraction of first-order traits is done through an image histogram while the extraction of second-order statistical traits is carried out with a kookurence matrix, which is an intermediate matrix that represents the relationship of resistance between pixels in the image in various directions of orientation and spatial distance.

2. Research Methods

This research is done gradually starting from. Acquisition of digital imagery. Digital image acquisition is a stage process in the form of taking image data as research test material. In this acquisition stage, in this study, research data is obtained from an open source website address with the website address https://www.kaggle.com/datasets/saife245/malaria-parasite-image-malaria-species then the image data is processed and used as training data After being acquired, it can be determined the training data to be used for research. After that, the image restoration process is carried out related to the removal or reduction of degradation in the image that occurs due to the process of image acquisition [11]. After obtaining research training data, the next is to do the process of improving the image. Image quality improvement is a pre-processing stage in image processing that aims to improve the quality of a digital image to be useful to reduce noise in the image taken. To improve the quality of an image, so that it can be more easily interpreted by the human eye is one of the activities that exist in digital image processing[12]. Histogram is a graph that shows the frequency of occurrence of each color gradation value [13]. The process of image improvement in this study using histogram equalization algorithm and low pass filter image. The extraction feature used to recognize objects in an image requires parameters that characterize the object. Each object is extracted based on certain parameters and grouped in a specific class. The values of these parameters are then used as input data in the identification / classification process. In the process of complex pattern recognition requires complex characteristics as well, therefore it is necessary to study what characteristics can really distinguish between one object and another object. The algorithm used in feature extraction is with the GLCM algorithm. In the process of doing this Classification, the values of the parameters that represent the characteristics of the objects in each class are used as input data. The data will be used as a material to classify malaria. GLCM is a technique for obtaining 2nd order statistical values by calculating the probability of proximity between two pixels at a certain distance (d) and angle (θ). The working process in the GLCM method is to form a co-occurrence on the image data, then determine the functional characteristics of the matrix between pixels.[14]. At the identification stage obtained a formula to be able to recognize objects. In the identification stage, generally two main processes are carried out, namely the training process and the testing process. The training process is carried out using a set of training data that contains feature parameters that are used to distinguish between objects from one object to another. The training process maps the training data towards the training target through a formula (identification /classification algorithm). The identification stage is used to recognize a malaria parasite based on the accuracy value obtained in the digital image of malaria. Here is the flowchart of research methods created as in the following figure:

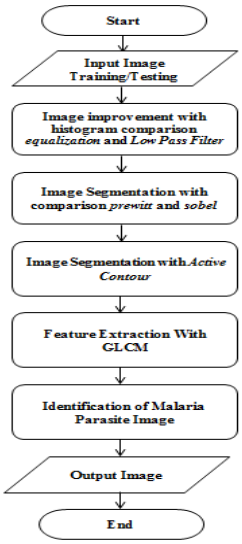

Figure 1. Research Method

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3. Results and Discussions

GLCM is a characteristic extraction method that uses texture calculations in the second order, which takes into account the pair of two pixels of the original image, while in the first order it uses statistical calculations based on the pixel value of the original image and does not pay attention to the pixels of the durability[15]. The author in the test uses the help of Tools Matlab. Analysis of results is intended to provide results regarding the algorithms used in solving problems in research. In the analysis of the results are sorted the algorithm processes used from the input stage to the output stage.

Data analysis is the initial stage that exists in identifying problems and analyzing the need to answer research problems. The study was titled "Identification of Malaria Parasite Patterns With Gray Level Co-Occurance Matrix Algorithm (GLCM)".

In data analysis, research needs become very functional because it must be owned by a study as a variable to be built. Data analysis can be input, process, output or in terms of data storage that must be owned by a system. The analysis of data needs used is: (a). Input: Image data of malaria parasites in png format, and tif as data training research conducted, (b). Process: Conducting analysis of feature extraction technique methods along with calculations about the identification of malaria parasites based on feature extraction techniques, (c). Output: The results of analysis of methods and calculations in the form of imagery that has been processed using algorithms used as research decisions.

3.1 Analysis of Research Image Process Stages

The stages that will be carried out in the image process in this study are: (1). Stages of image acquisition, (2). Stages of image improvement with comparison of histogram equalization and low pass filter, (3). Stages of image segmentation with prewitt and sobel comparisons, (4). Feature extraction stage with GLCM (Gray Level Co-Occurance Matrix), (5). Identification stage, (6). The result of the decision.

In this study, data will be used and used in the analysis of calculations that will later be carried out feature extraction techniques. The research data used is malaria image data consisting of 4 species namely Falciparum, Malariae, Ovale, and Vivax and each species has a ring stage, Trophozoite, Schizont, and Gametocyte. Here's the explanation of the training data:

Training data:
Falciparium Parasites:
There are 60 images consisting of stadiums: 43 Images of Stadium R (Ring), 3 Images of Stadium T (Trophozoite), 10 Images of Stadium S (Schizont), 3 Rs Combined Stadium Images (Ring Schizont), 1 Sr Combined Stadium Image (Schizont Ring).

Malariae Parasites:
There are 22 images consisting of stadiums: 6 Images of Stadium G (Gametocyte), 8 Images of Stadium T (Trophozoite), 7 Images of Stadium S (Schizont),1 RT Combined Image (Ring Trophozoite)

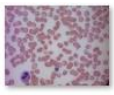
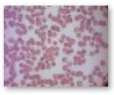
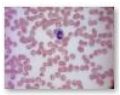
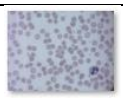
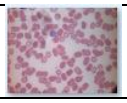
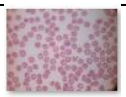
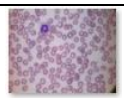
Ovale Parasites:
There are 14 images consisting of stadiums:
9 Images of Stadium T (Trophozoite), 1 Image of Stadium G (Gametocyte), 1 Image of Stadium R (Ring), 1 GR Combined Image (Gametocyte Ring), 1 RT Combined Image (Ring Trophozoite), 1 TR Combined Image (Trophozoite Ring).

Vivax Parasites:
There are 22 images consisting of stadiums:
13 Images of Stadium R (Ring), 3 Images of Stadium G (Gametocyte), 2 Images of Stadium S (Schizont), 2 Images of Stadium GR (Gametocyte Ring), 1 Image of Stadium RR (Ring Ring)

3.2 Data Collection

The sample data used includes:

Table 1. Malaria Parasite Image input data

Testing Image		
Parasit Falciparum		
RS	R	R
		
Parasit Malariae		
G	T	G
		
Parasit Ovale		
GR	T	T
		
Parasit Vivax		
GR	S	R
		

3.3 Steps of Algorithms:

1. Digital Image Acquisition

At this stage of digital image acquisition, research data is taken from secondary data derived from websites with the address: https://www.kaggle.com/datasets/saife245/malaria-parasite-image-malaria-species. This data is free and open source so it can be used by anyone with useful research purposes. The malaria parasite data provided is PNG and tif format as shown in the figure below:

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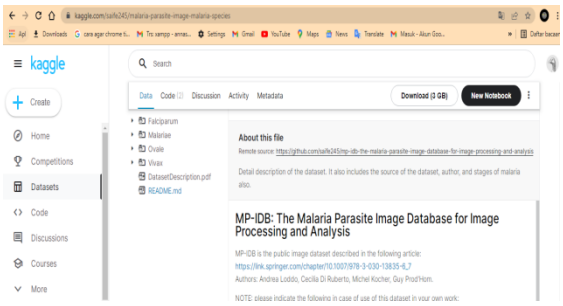


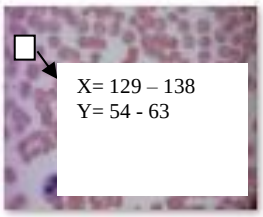
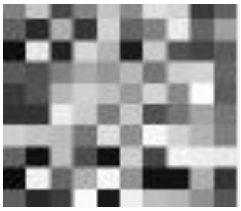
Figure 2 Research data sources

2. Stages of Image Improvement with Comparison *Histogram Equalization* and *Low Pass Filter*

2.1 Reading Imagery in pixel data

Before doing the stages of digital image improvement, it is done first to read the image by converting the image in the form of pixel data to get the numbers R, G, and B. In this study, the author used image data with tif and png format obtained from the website as training data and testing data that has constituent pixels in the form of numbers referred to as matrix data. In this analysis calculation sample, the author only took a sample of pixel data from the Falciparium image with rs stage (Ring and Schizont) with 10 x 10 pixels to be tested calculations. Here is the image that the RGB value will look for:

Table 2. Malaria Parasite Image Sample

Original Image	Image Made Into Pixel Box
	

The author takes samples from the image with the help of MATLAB Tools to obtain numbers and image identities, with the following image identities: Pixel Length = 2592, Pixel Width = 1944, Bit = 24, Red= 163.127, Green = 139.617, Blue = 156.2.

The image axis starts from x as far as 129 to 138 and the y axis starts from 54 to 63, with its RGB (Red, Green, Blue) values [143, 85, 126]. Each x and y is taken as much as 9 pixels. In the image, it consists of Red, Green, and Blue components and each component has a matrix value. To find out each of the Red, Green, and Blue values.Here is a table of image pixel values from figure 3.

Table 3. Red Image

Red Image								
143	129	136	135	142	141	148	151	152
144	136	144	141	139	138	148	151	152
148	140	152	151	141	132	145	149	152
149	145	151	150	145	144	153	155	152
147	142	147	147	146	154	156	149	152
146	141	146	148	145	146	147	142	147
148	139	142	142	141	144	137	139	137
148	139	144	141	139	149	145	144	145
146	143	150	145	140	152	142	145	142
151	147	146	145	145	148	147	145	147

Table 4. Green Image

Green Image								
97	85	78	90	92	94	89	92	85
91	89	86	95	93	86	82	94	89
97	99	93	102	97	85	74	90	99
102	102	97	99	95	87	87	97	102
101	102	93	92	91	91	101	103	102
102	97	91	94	95	94	97	99	97
106	94	87	94	98	98	95	106	94
103	91	86	98	100	100	94	108	91
96	89	93	104	96	96	94	100	89
102	100	99	98	92	92	98	106	100

Table 5. Blue Image

Blue Image								
128	109	116	119	126	129	141	116	119
127	113	120	121	118	120	139	120	121
131	118	127	129	120	111	132	127	129
133	122	125	127	124	125	138	125	127
132	120	120	123	126	138	143	120	123
131	119	120	124	125	132	134	120	124
129	116	119	121	125	133	124	119	121
126	116	124	125	125	142	135	124	125
124	123	133	133	128	148	137	133	133
134	131	132	133	132	139	144	132	133

2.2 Get a Greyscale Image value

As seen in tables 3 to table 5 it can be seen that each red, green and blue values are separate, then the image is used to get the pixel value of the greyscale image. Greyscale image values are used to minimize rgb image values as well as to obtain grayhood degrees. RGB images and greyscale images have differences in their constituent image information. The number of colors on the greyscale image is 256, because the grayscale image of the number of bits is 8, so the number of colors is 28 = 256, the value is in the range of 0-255, so the intensity value of the greyscale image will not exceed 255 and not less than 0. The equation is f(x,y)= intensity value, with x and y being the position of the intensity value. While the color composition for RGB images is R =255 (8bit). G=255 (8bit) and B=255 (8bit) are often referred to as 24 bit or truecolor intensity images. The number of RGB colors is 28*28*28=16,777,216. So that the number of bytes required for an RGB image file is more than 3 times the space of a greyscale file. Each pixel of a greyscale image of 256 color gradations is represented by 1 byte and 1 pixel of rgb image is represented by 3 bytes, each byte representing red, green, blue in memory. RGB images can be converted into greyscale images by summing the values of red, green, blue colors and then divided by 3. Systematically greyscale formula as follows:

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$$f_0 = (x, y) = \frac{f_i^R(x,y) + f_i^G(x,y) + f_i^B(x,y)}{3} \quad (1)$$

Description: f as variable. R, G, B as Red, Green, Blue colors.

x, y as the dot axis.

The greyscale image value is rounded up first with the round function to get the nearest value. So that the results of greyscale images are obtained in the Table 6.

Table 6. Grayscale image of table after conversion to grayscale via calculation formula:

Greyscale Image								
123	108	110	115	120	122	126	120	119
121	113	117	119	117	115	123	122	121
126	119	124	128	120	110	117	122	127
128	123	125	126	122	119	126	126	127
127	122	120	121	121	128	134	124	126
127	119	119	122	122	124	126	121	123
128	117	116	119	122	125	119	122	118
126	116	118	122	122	131	125	126	121
122	119	126	128	122	132	125	126	122
129	126	126	126	123	127	130	128	127

Next is to calculate the histogram equalization equalization on an image with the k bit grayness scale is as in the following equation:

$$K_0 = round(\frac{C_i * (2^k - 1)}{w.h}) \quad (2)$$

Description: Ci = Cumulative Distribution Of Grayish Scale Value To –i From Original Image, Round = Rounding Function To The Nearest Number, Ko = Invalidity Value of Histogram Equalization Result, W= Image Width, H= Image Height.

So that the results of the calculation become as :

Table 7. Equalization Histogram Calculation Results

No	Color (x)	Frequency (y)	Cumulative Distribution
1.	123	5	5
2.	108	1	6
3.	110	2	8
4.	115	2	10
5.	120	5	15
6.	122	16	31
7.	126	15	46
8.	119	12	58
9.	121	6	64
10.	113	1	65
11.	117	5	70
12.	124	4	74
13.	128	6	80
14.	127	6	86
15.	125	5	91
16.	134	5	96
17.	116	2	98
18.	118	2	100
19.	131	1	101
20.	132	1	102
21.	129	1	103
22	130	1	104

Next calculate the validity value of the cumulative distribution calculation using the formula:

$$K_0 = round\left(\frac{C_i * (2^k - 1)}{w.h}\right) \quad (3)$$

Here are the results of the histogram equalization calculation:

Table 8. Equalization Histogram Calculation Results

Color (x)	Frequency (y)	Cumulative Distribution	Round	Result
123	5	5	295	2,95
108	1	6	378	3,78
110	2	8	496	4,96
115	2	10	620	6,2
120	5	15	885	8,85
122	16	31	1488	14,88
126	15	46	2254	22,54
119	12	58	3016	30,16
121	6	64	3712	37,12
113	1	65	4095	40,95
117	5	70	4130	41,3
124	4	74	4440	44,4
128	6	80	4640	46,4
127	6	86	4988	49,88
125	5	91	5369	53,69
134	5	96	5664	56,64
116	2	98	6076	60,76
118	2	100	6200	62
131	1	101	6363	63,63
132	1	102	6426	64,26
129	1	103	6489	64,89
130	1	104	6552	65,52

Furthermore, the results are displayed in the form of an equalization histogram result curve below:

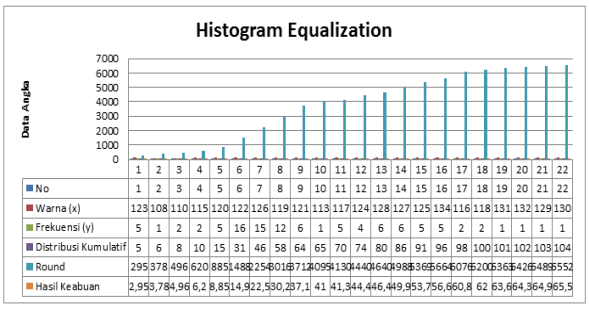

Figure 3. Equalization histogram result curve

Then, perform the stages of the low pass filter (LPF) algorithm. In this algorithm all values are positive and the sum of all values is equal to one. All kernel coefficients must be positive. Low pass filter is a filter process that skips image components with low intensity values and dampens image components with high intensity values. Low pass filters produce imagery to be smoother and more blurry. Low pass filters use average operation in the process because they are part of smoothing filters. The following are the terms of use of LPF with the formula:

H (x,y) > = 0

$\sum_{xy} H(x, y) = 1$

Next use the greyscale matrix image data to perform calculations with the kernel used from the Table 8.

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Table 8. Kernel LPF

0	1	0
1	4	1
0	1	0

So that calculations are carried out:

Table 9. Multiplication Results with Kernel

Result								
721	778	780	809	834	849	869	847	836
846	917	934	953	942	932	972	974	971
872	962	985	1001	957	911	949	980	1000
888	986	993	1000	974	962	1000	1003	1012
885	977	967	973	977	1010	1040	1003	1002
882	961	953	969	977	997	1002	979	977
882	947	937	958	976	996	974	972	955
870	944	952	975	985	1028	1001	998	969
862	966	995	1008	993	1033	1013	1005	984
764	878	882	881	867	893	900	895	884

Next calculate MSE (Mean Square Error), and PSNR (Peak Signal-to-Noise Ratio) as parameters used as indicators to measure the similarity of two images. These parameters are often used to compare the results of image processing with the initial imagery or original imagery. At this stage, a comparison process is carried out between the histogram equalization and the low pass filter to get the best results to be used to the next stage.

The MSE and PNSR formulas are:

$$MSE = \frac{1}{mxn}\sum_{i=0}^{n-1}\sum_{j=0}^{m-1}[f(i,j) - g(i,j)]^{\ 2} \qquad (4)$$

$$PSNR = 10\ log_{10}\frac{255^2}{MSe}$$

So that the accuracy value of MSE and PSNR is obtained:

Table 10. Result Of MSE and PSNR

Histogram Equalization		*Low Pass Filter*	
MSE	PSNR	MSE	PSNR
2112604	0,03078 db	21601,6	3,0102 db

So, the best accuracy value between the histogram equalization algorithm and the low pass filter is the low pass filter accuracy value with a PSNR value of 3.0102 db and an MSE value of 21601.6.

3. Stages of The Segmentation Process With Prewitt And Sobel Comparison

Segmentation is the stage of separating an object from its background. The mettode segmentation used in this study is prewitt and sobel. The method is part of edge detection i.e. removing edges on image objects. The prewitt method uses an equation with the value of the constant c used is worth 1. The prewitt operator does not emphasize weighting on pixels closer to the kernel's central point. This method takes the principle of the laplacian function known as the function to evoke the high pass filter. Prewitt method equation formula:

$$Sx = \begin{matrix} 1 & 0 & -1 \\ 1 & 0 & -1 \\ 1 & 0 & -1 \end{matrix}$$

$$Sy = \begin{matrix} -1 & -1 & -1 \\ 0 & 0 & 0 \\ 1 & 1 & 1 \end{matrix}$$

Then M =$\sqrt{Sx^2 + Sy^2}$

The calculation stage starts from the results of the low pass filter because the results of the low pass filter get the best results. So the Table 11.

Table 11. Result of Low Pass Filter

Result of Roundup								
80	87	87	90	93	95	97	95	93
94	102	104	106	105	104	108	109	108
97	107	110	112	107	102	106	109	112
99	110	111	112	109	107	112	112	113
98	109	108	109	109	113	116	112	112
98	107	106	108	109	111	112	109	109
98	106	105	107	109	111	109	108	107
97	105	106	109	110	115	112	111	108
96	108	111	112	111	115	113	112	110
85	98	98	98	97	100	100	100	99

Here are the results of calculations with the Prewitt algorithm:

Table 12. X Axis Prewitt Results

X Axis Prewitt Results						
-190	-186	-178	-173	-192	-202	-196
-223	-215	-204	-195	-215	-225	-223
-229	-221	-216	-213	-223	-215	-215
-228	-223	-224	-226	-231	-216	-218
-221	-220	-224	-229	-228	-220	-223
-220	-220	-223	-229	-223	-213	-215
-227	-221	-218	-227	-222	-212	-209
-231	-218	-215	-229	-227	-223	-216

Tabel 13. Y Axis Prewitt Results

Y Axis Prewitt Results						
-134	-149	-161	-181	-184	-174	-170
-178	-199	-205	-211	-207	-204	-212
-195	-221	-219	-208	-195	-202	-219
-205	-226	-221	-216	-214	-221	-231
-202	-220	-215	-218	-227	-235	-234
-197	-211	-210	-212	-215	-224	-223
-186	-203	-209	-213	-212	-218	-215
-197	-222	-228	-235	-234	-238	-232

Tabel 14. Prewitt Magnitude Results

Prewitt Magnitude Results				
232,4995	238,3212	240,0104	250,3797	265,9323
285,3296	292,9607	289,2075	287,3082	298,4527
300,7757	312,5412	307,5988	297,7129	296,233
306,6089	317,498	314,6697	312,6212	314,892
299,4077	311,127	310,4851	316,1724	321,7344
295,3117	304,8295	306,3152	312,0657	309,7644
293,4706	300,0833	302,0017	311,2844	306,9658
303,5951	311,1398	313,3832	328,125	326,0138

After obtaining the results of the prewitt method, the next step is to calculate the sobel method. The sobel

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method is one of the operators that avoids the calculation of gradients at the interpolation point. This operator uses a kernel size of 3x3 pixels for gradient calculations so that the approximate gradient is right in the middle of the window. Suppose the arrangement of pixels around pixels x, y. Sobel method equation formula:

$$Variabel\ x\ dan\ y = \begin{matrix} a0 & a1 & a2 \\ a7 & (x,y) & a3 \\ a6 & a5 & a4 \end{matrix}$$

$$Sx = \begin{matrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{matrix}$$

$$Sy = \begin{matrix} 1 & 2 & 1 \\ 0 & 0 & 0 \\ -1 & -2 & 1 \end{matrix}$$

Description:

F(x, y) = the pixel size of the image in the matrix, an= pixel value on the matrix, (x, y) = the value of the new pixel of the convolution result as the middle value

Partial derivatives are calculated by:
S_x = (a2+ca3+a4)-(a0+ca7+a6) = Vertical Axis
S_y = (a0+ca1+a2)-(a6+ca5+a4) = Horizontal Axis
C is a constant that is worth 2.

The sobel operator is the magnitude of the gradient calculated by:

Then G =$\sqrt{Sx^2 + Sy^2}$

G is a large gradient in the middle of the kernel point. With the conversion image data, the sobel algorithm process is carried out with the results:

Table 15. X Axis Sobel Result

X Axis Sobel Result						
770	812	815	819	829	827	840
822	868	863	857	860	854	877
833	881	874	874	880	874	896
826	873	869	882	892	889	902
817	861	861	878	885	884	886
813	855	859	879	879	884	873
816	861	868	893	886	898	879
800	850	855	876	867	880	865

Table 16. Y Axis Sobel Result

Y Axis Sobel Result						
542	566	587	595	585	589	592
610	636	647	643	632	648	657
629	655	658	642	636	656	664
636	655	657	652	654	669	670
629	643	645	654	673	678	670
619	635	645	651	671	672	665
616	641	652	655	668	666	659
596	622	631	636	649	650	643

Table 17. Sobel Magnitude Results

Sobel Magnitude Results				
941,628	989,798	1004,39	1012,32	1014,63
1023,61	1076,07	1078,6	1071,4	1067,25
1043,81	1097,81	1094	1084,45	1085,77
1042,48	1091,4	1089,41	1096,83	1106,07
1031,08	1074,6	1075,8	1094,81	1111,82
1021,83	1065,01	1074,2	1093,82	1105,84
1022,41	1073,41	1085,6	1107,46	1109,6
997,605	1053,27	1062,63	1082,53	1083

The provisions of magnitude in the sobel method are:
If G>=128 then the magnitude value becomes 255, otherwise the magnitude value becomes 0:

Information:
G is an image pixel, So the results of table 16 above by following the rules rather than the sobel method so that it becomes:

Table 18. Magnitude Decision Results

Magnitude Decision Results				
255	255	255	255	255
255	255	255	255	255
255	255	255	255	255
255	255	255	255	255
255	255	255	255	255
255	255	255	255	255
255	255	255	255	255
255	255	255	255	255

Next is to compare the accuracy results of the prewitt algorithm with sobel with MSE and PSNR. So that MSE and PSNR Accuracy scores are obtained:

Tabel 19. Nilai Akurasi MSE dan PSNR

Algoritma Prewitt		Algoritma Sobel	
MSE	PSNR	MSE	PSNR
22601.6	15.0102 db	21601,6	3,0102 db

So, the best value between prewitt algorithm and sobel algorithm is prewitt algorithm with PSNR 15.0102 db and MSE 22601.6.

3.4 GLCM Algorithm

At this stage, the process of extracting features from grayscale imagery with GLCM (Gray Level Co-occurrance Matrix) is carried out. Extractive texture features are done to take characteristics on the image, this feature is very influential in identifying data to determine chickens contain formalin. The steps in extracting the GLCM (Gray Level Co-occurrance Matrix) feature are modeled in the flowchart in the Figure 4.

Analysis of the GLCM (Gray Level Co-occurrance Matrix) extraction process modeled in the flowchart in the daat image is described as follows

1. The image is inserted into the variable.
2. Matrix co-occurrence process is carried out where the process is divided into 4 angles θ which is 0 degree, 45 degree, 90 degree and 135 degree The process is done by calculating how many pairs of pixels with the same neighboring pixels. Then the amount is entered into a new matrix.

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3. In the symmetric process, a transpose matrix is created based on a new matrix from the calculation results in process 2, then a new matrix and a transpose matrix are added.
4. The result of the symmetrization matrix is normalized, after normalization is completed, all the normalization result matrices are added.
5. The last stage is the calculation of the extraction of energy and entropy features in accordance with the formula stated in Figure 4.
6. The result of this process is the value of energy texture features and homogenity.

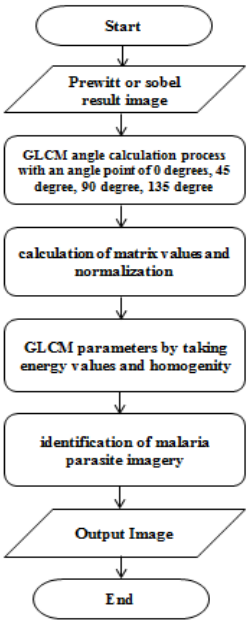

Figure 4. Flowchart of GLCM

From the analysis, it can be done manual calculation of feature extraction from grayscale imagery by using Gray Level Co-occurrance Matrix. The calculation uses the matrix and the result of the RGB image value (Red, Green, Blue) converted to gray scale. In the calculation of co-occurrence, the new matrix as a co-occurrence process placeholder must have a width and height at least equal to the highest pixel value on the grayscale matrix. For matrix results of rgb (Red, Green, Blue) color transformation to grayscale has the highest value of 255 pixels, which means the width and height of the co-occurrence matrix must have a minimum of 255 pixels. In order to facilitate manual calculations, the values of the grayscale matrix are converted into matrices with random values between range of values 0 to 4. The values of the grayscale matrix and co-occurrence before the process are indicated by the metrics below.

All matrices of normalization are summed up and divided in total from angular orientation, where the total of 4 (four) angular orientations is 0 degree, 45 degree, 90 degree and 135 degree.

Tale 19. Division Process Matrix with Total Angular Orientation

0,744/4	0,443/4	0,139/4	0,224/4	0,220/4
0,443/4	0,060/4	0,026/4	0,134/4	0,087/4
0,139/4	0,026/4	0,050/4	0,050/4	0,150/4
0,249/4	0,076/4	0,050/4	0/4	0,052/4
0,220/4	0,119/4	0,180/4	0,084/4	0,025/4

Table 20. Matrix of Division Results with Total Angular Orientation

Angular Orientation				
0,186	0,110	0,034	0,056	0,055
0,110	0,015	0,006	0,033	0,021
0,062	0,006	0,012	0,012	0,037
0,062	0,019	0,012	0	0,013
0,055	0,029	0,045	0,021	0,006

The table above is a matrix that is ready to be extracted. Energy Feature Extraction is done using entropy values. The calculation of the extraction of energy and entropy features is indicated as follows:

1. Energy Feature Extraction:

$$\sum_{ij} p(i,j)^2$$

$= (0{,}186^2) + (0{,}110^2) + (0{,}034^2) + (0{,}056^2) + (0{,}055^2) + (0{,}110^2) + (0{,}015^2) + (0{,}006^2) + (0{,}033^2) + (0{,}021^2) + (0{,}062^2) + (0{,}006^2) + (0{,}012^2) + (0{,}012^2) + (0{,}037^2) + (0{,}062^2) + (0{,}019^2) + (0{,}012^2) + (0^2) + (0{,}013^2) + (0{,}055^2) + (0{,}029^2) + (0{,}045^2) + (0{,}021^2) + (0{,}006^2)$

= 0,0345 + 0,0121 + 0,0011 + 0,0031 + 0,0030 + 0,0121 + 0,0020 + 0,000036 + 0,0010 + 0,0004 + 0,0038 + 0,000036 + 0,0001 + 0,0001 + 0,0013 + 0,0038 + 0,0003 + 0,0001 + 0 + 0,0002 + 0,0030 + 0,0008 + 0,0020 + 0,0004 + 0,000036 = 0,0853

2. Homogenity Feature Extraction:

$$\sum_{i,j} p(i,j) log_2(p(i,j))$$

$= (0{,}186 log_2\ 0{,}186\ ) + (0{,}110\ log_2 0{,}110) + (0{,}034\ log_2\ 0{,}034\ ) + (0{,}056\ log_2\ 0{,}056\ ) + (0{,}055\ log_2\ 0{,}055\ ) + (0{,}110\ log_2\ 0{,}110\ ) + (0{,}015\ log_2\ 0{,}015\ ) + (0{,}006\ log_2\ 0{,}006\ ) + (0{,}033\ log_2\ 0{,}033\ ) + (0{,}021\ log_2 0{,}021) + (0{,}062 log_2 0{,}062) + (0{,}006\ log_2 0{,}006) + (0{,}012\ log_2 0{,}012) + (0{,}012\ log_2 0{,}012) + (0{,}037\ log_2 0{,}037) + (0{,}062\ log_2 0{,}062) + (0{,}019\ log_2 0{,}019) + (0{,}012\ log_2 0{,}012) + (0\ log_2 0) + (0{,}013\ log_2 0{,}013) + (0{,}055\ log_2 0{,}055) + (0{,}029\ log_2 0{,}029) + (0{,}045\ log_2 0{,}045) + (0{,}021\ log_2 0{,}021) + (0{,}006\ log_2 0{,}006)$

= (-0.4513) + (-0.3502) + (-0.1658) + (-0.2328) + (-0.2301) + (-0.3502) + (-0.0908) + (-0.0442) +

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(-0.1624) + (-0.1170) + (-0.2487) + (-0.0442) + (-0.0765) + (-0.0765) + (-0.1759) + (-0.2487) + (-0.1086) + (-0.0765) + (0) + (-0.0814) + (-0.2301) + (-0.1481) + (-0.2013) + (-0.1170) + (-0.0442)
= -4.0725, so that the results become positive, -4.0725 x -1
= 4.0725

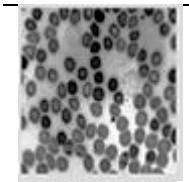
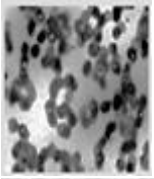
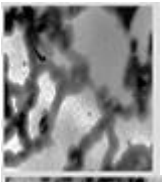
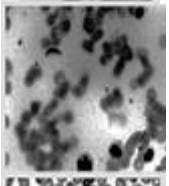
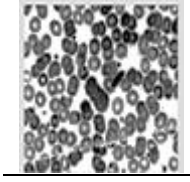
So that the results of the calculation are displayed as below:

Table 21.GLCM Decision Value

	0 degree	45 degree	90 degree	135 degree
Energy	0.56916	0.54281	0.5759	0.53721
Homogenity	0.84443	0.82753	0.8523	0.82414

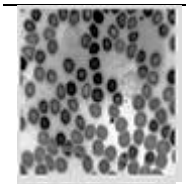
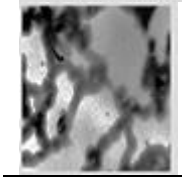
Based on the above process, it was found that the process of identifying malaria parasite patterns by extracting GLCM algorithms with Energy and Homogenity parameters is:

Table 22. Energy and Homonegity Calculation Results from GLCM

Image	Average Energy	Average Homogenity	Value MSE
	0.55627	0.8371	0.24358
	0.22274	0.98532	0.24358
	0.28735	0.9793	0.24358
	0.32907	0.97073	0.24358
	0.74102	0.99844	0.24358
	0.34758	0.99129	0.24358

Obtained rules if the average value of energy > = 0.50 then the decision to identify the highest malaria image so that:

Table 23.Average of Energy, Homogenity and MSE

Image	Average Energy	Average Homogenity	Value MSE
	0.55627	0.8371	0.24358
	0.74102	0.99844	0.24358

4. Conclusion

From the test results using 5 malaria parasite test image data, it was found that image 1 has an average accuracy value of 0.55627, an average Homonegity of 0.8371, PSNR of 6.1336db, and MSE of 0.24358. Image 2 has an average accuracy value of 0.22274, an average Homonegity of 0.98532, a PSNR of 6.1336db, and an MSE of 0.24358. Figure 3 has an average energy accuracy value of 0.28735, an average accuracy value of Homonegity of 0.9793, a PSNR of 6.133db, and an MSE of 0.24358. Figure 4 has an average energy accuracy value of 0.32907, and an average accuracy value of Homonegity of 0.97073, PSNR of 6.133db, and MSE of 0.24358. Image 5 has an average accuracy value of 0.74102 energy, an average Homonegity of 0.99844, a PSNR of 6.133db, and an MSE of 0.4358. Figure 6 has an accuracy value of an average energy of 0.34758, an average accuracy value of homogenity of 0.99129, pnsr of 6.133db and MSE of 0.24358. Obtained rules if the average value of energy > = 0.50 then the pattern of malaria parasites is very clear, namely Image 1 and image 5 with a pattern of malaria parasites is very clear.

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