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ANALYSIS OF RON 92 OIL BASED ON MORPHOLOGY AND HISTOGRAM TECHNIQUES

Indah Purnama Sari [1*], Zainal Azis[2], Ahmad Riady Hasibuan[3]

[1]*Department of Information Technology, Faculty of Computer Science and Information Technology, Universitas Muhammadiyah Sumatera Utara*
[2]*Department of Mathematics Education, Faculty of Teacher Training and Education, Universitas Muhammadiyah Sumatera Utara*
[3]*Elementary School Teacher Education, Faculty of Teacher Training and Education, Universitas Muhammadiyah Sumatera Utara*
Jln. Kapten Muchtar Basri No. 3, Medan, 20238, Indonesia

Corresponding author's e-mail: * **indahpurnama@umsu.ac.id**

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ABSTRACT

In oil quality monitoring, digital imagery has become an essential tool. With the advancement of technology, digital imagery can be used to visualize oil samples and perform analysis quickly and accurately. However, effective image processing techniques are needed to generate useful information from digital images. The main problem faced in fuel quality evaluation is the inaccuracy and inconsistency of manual methods. Manual methods often require expensive equipment and trained workers and are prone to human error. Therefore, a more efficient and accurate method is needed. Morphological and histogram techniques on digital images offer a potential solution to this problem. One of the common techniques used in image processing is morphological techniques, which involve mathematical operations on images to change or describe certain image features. This technique can help identify important structures and patterns in Ron 92 oil images, such as quality and cleanliness. In addition, histograms are helpful statistical tools in image analysis, which represent the distribution of pixel intensities in an image. Histogram analysis can provide insight into the distribution of pixel intensity values in an oil image, which is relevant to the quality and homogeneity of the oil.

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1. INTRODUCTION

Gasoline with Research Octane Number (RON) 92 is one type of fuel that is widely used by motor vehicles in Indonesia [1], [2]. The quality and authenticity of this fuel are essential to ensure the performance of the vehicle engine and avoid losses for consumers. One method that can be used to evaluate oil quality is through digital image analysis. Morphology and histogram techniques are two methods that we applied to this analysis.

In oil quality monitoring, digital imagery has become an essential tool. With the advancement of technology, digital imagery can be used to visualize oil samples and perform analysis quickly and accurately. However, effective image processing techniques are needed to generate useful information from digital images.

The main problem faced in fuel quality evaluation is the inaccuracy and inconsistency of manual methods. Manual methods often require expensive equipment and trained workers and are prone to human error. Therefore, a more efficient and accurate method is needed. Morphological and histogram techniques on digital images offer a potential solution to this problem.

One of the common techniques used in image processing is morphological techniques, which involve mathematical operations on images to change or describe certain image features. This technique can help identify essential structures and patterns in Pertalite oil images, such as quality and cleanliness.

In addition, histograms are helpful statistical tools in image analysis, representing the distribution of pixel intensities in an image. Histogram analysis can provide insight into the distribution of pixel intensity values in an oil image, which is relevant to the quality and homogeneity of the oil. However, although morphological and histogram techniques have been widely used in digital image processing, there has been no specific research evaluating both techniques' effectiveness in monitoring the quality of RON 92 oil at gas stations.

At Pertamina Medan gas stations, there is a need to ensure the quality of RON 92 oil sold. Morphological and histogram techniques and digital image analysis enable rapid and accurate oil quality assessment, including identifying contamination, composition variations, and deviations from established standards.

Researchers use morphology and histograms because both methods offer advantages over other techniques. Histograms are particularly suitable for applications that require intensity distribution analysis or image contrast processing. This method is beneficial for enhancing image quality, normalizing lighting, or detecting object distribution. On the other hand, morphology is more effective than histograms when the objective is to analyze the shape or structure of objects, remove noise, or detect objects in more straightforward or well-segmented images. Both methods have their strengths and can often be used together in image processing to achieve better results, depending on the specific application needs.

This study evaluates RON 92 fuel using morphological and histogram techniques in digital image processing. This study attempts to apply an image-based method to assess fuel quality, an innovative fuel technology approach. However, based on the description given, there are several challenges in this study:

a. There is no Adequate Basis of Truth - The application of digital image processing technology in fuel quality evaluation is still in the exploration stage, so the validity of this method has not been fully tested.

b. Visual Fuel Quality Evaluation - This study highlights the importance of visual analysis in assessing fuel quality, such as for Pertamax. However, it is unclear how the correlation between the analyzed visual characteristics and fuel quality parameters is commonly used in the industry.

c. Relation to Fuel Performance Evaluation - The method used in this study needs to be linked more deeply to the technical parameters that determine fuel performance, such as combustion efficiency, octane content, and residue produced.

2. RESEARCH METHODS

2.1 Morphological Operations

Morphological operations are mathematical functions, known as nonlinear filters in image processing, that process images based on morphology or shape [4], [5]. These nonlinear filters depend on the relative position of pixels because the pixel values change according to neighboring pixels. Morphological operations are one of the essential techniques in digital image processing that are used to manipulate the shape, structure, and texture of objects in an image. This operation utilizes mathematical concepts from set theory to transform and enhance images [6]. This concept makes it suitable for binary image processing. Changes to the image are made by small binary filters or kernels known as structuring elements. Image morphological operations are a process that aims to change the shape of objects in the original image. This process can be performed on grayscale images or binary images [7].

2.2 An Image Histogram

An image histogram is a graph describing the distribution of pixel intensity values of an image or a particular part. From a histogram, we know the relative frequency of occurrence of the intensity in the image. Histograms can also show a lot about the brightness and contrast of an image. Therefore, histograms are valuable tools in qualitative and quantitative image processing [8], [9]. In the histogram, there are several calculations; for example, a digital image has L degrees of gray from 0 to L - 1 (for example, in an image with 8-bit gray quantization, the gray value is from 0 to 255. Mathematically, we calculate the image histogram by using the formula:

$$h_i = \frac{n_i}{n}, I = 0,1,\dots,-1 \quad \text{(decrease)} \tag{1}$$

In this case:

$n_i =$ Number of pixels that have gray level i
$n =$ Total number of pixels in the image

2.3 Research Framework

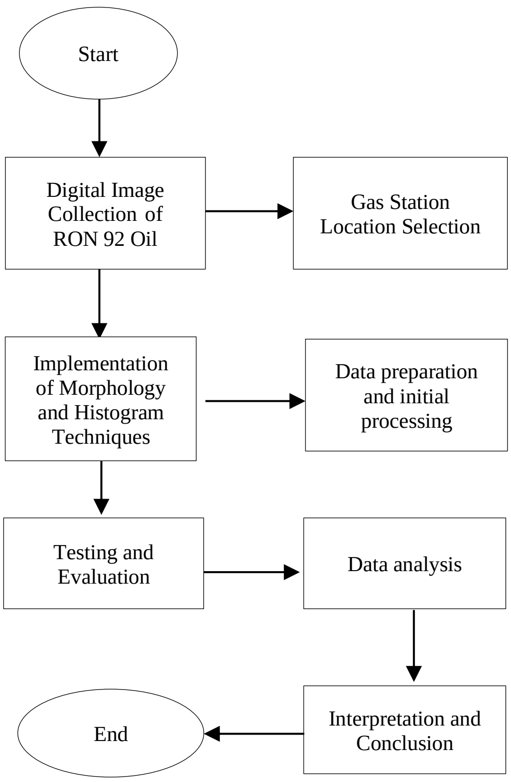

Figure 1. Research Framework

Figure 1 is a research framework consisting of:

a. Digital Image Collection of RON 92 Oil: Gathering digital images related to RON 92 oil, likely for analysis or processing.

b. Gas Station Location Selection: Choosing specific locations of gas stations to focus on in the study.

c. Implementing morphology and histogram techniques involves applying morphological image processing methods and histogram-based analysis to the collected images to enhance their quality and extract meaningful information.

d. Data Preparation and Initial Processing: Preparing the collected data and performing initial processing to prepare it for further analysis.

e. Testing and Evaluation: Tests and evaluations are conducted to assess the effectiveness or performance of the applied techniques.

f. Data Analysis: Analyzing the processed data to extract meaningful insights or results.

g. Interpretation and Conclusion: Interpret the findings and draw conclusions based on the analysis.

3. RESULTS AND DISCUSSION

3.1 Data Processing Results

In this sub-chapter, the results of digital image data processing of RON 92 oil at the Pertamina Medan Tembung Gas Station using morphology and histogram techniques will be presented in detail. Data processing is carried out through several stages, from image acquisition, preprocessing, application of morphology techniques, dilation, erosion, opening, and closing to histogram analysis.

Each stage's results will be presented in tables, graphs, and relevant images to illustrate the techniques' effectiveness clearly. Researchers obtained oil images from four Pertamina gas stations in Medan Tembung District.

3.2 Application of Morphological Techniques

This study applies several basic morphological operations such as dilation, erosion, opening, and closing to oil images. Dilation is used to enlarge bright areas in the image, allowing the identification of features such as large particles or air bubbles. Conversely, erosion is used to reduce bright regions, helping to highlight small features or gaps in the image.

In this study, area change refers to modifying the size and distribution of features in oil images by applying morphological operations such as dilation, erosion, opening, and closing. These operations are used in digital image processing to extract visual information from oil samples, which can provide insight into their quality.

Overall, the area changes in the oil image reflect essential aspects of oil quality, such as homogeneity, presence of contaminants, and structural stability. If the oil has large bright areas due to air bubbles or large particles, its quality may be lower. Conversely, a more uniform distribution after morphological operations may indicate a purer and more stable oil.

The opening technique, a combination of erosion followed by dilation, removes small noise without changing the original shape of the objects in the image. The closing technique, which consists of dilation followed by erosion, is used to fill small gaps in objects and smooth irregular object boundaries. For example, the test image that will be used is the image of Pertamax 1 oil, which can be seen in **Figure 2**.

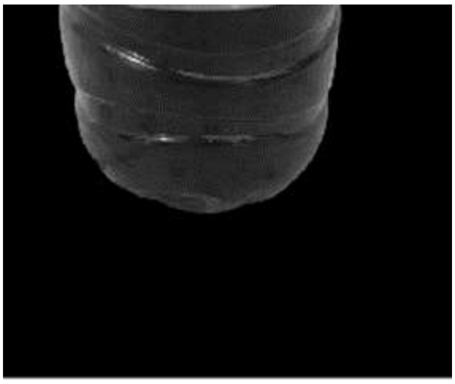

Figure 2. Test Image

Where the **Figure 2** has been processed and has the following white pixel values of dilation, erosion, opening, closing, and binary image:

Binary Image	41704
Dilation	44561
Erosion	39934
Opening	42216
Closing	42219

In the classification process, the Percentage of Area Change value will be calculated in each dilation, erosion, opening and closing process. It can be calculated using the following formula:

$$Area\ Change\ =\ After\ Processing\ -\ Before\ Processing \tag{2}$$

$$Percentage\ Change\ in\ Area = \frac{Area\ change}{Pre - Processing\ Area4} \times 100\% \tag{3}$$

For example, between the Pertamax 1 image by taking the dilation operation as follows:

$Area\ Change = 44561 - 41704\ =\ 2857$

$Percentage\ Change\ in\ Area = \frac{2857}{41704} \times 100\% = 6{,}85\%$

RON 92 image with erosion operation:

$Area\ Change = 3994 - 41704\ =\ 1770$

$Percentage\ Change\ in\ Area = = \frac{-1770}{41704} \times 100\% =\ -4.25\%$

Table 1. Percentage Change in Area

No	Image	Before Processing	After Processing	Area Change	Percentage
1		41704	42219	515	1.24%
2		46579	47126	547	1.17%
3		51247	51862	615	1.20%
4		44994	45884	890	1.98%
5		79437	79632	195	0.25%
6		83995	84192	197	0.23%

Based on **Table 1**, it can be concluded as follows:

a. RON 92 1: Area change of 515 units, with a percentage decrease of 1.24%

b. RON 92 2: Area change of 547 units, with a percentage decrease of 1.17%

c. RON 92 3: Area change of 615 units, with a percentage decrease of 1.20%

d. RON 92 4: Area change of 890 units, with a percentage decrease of 1.98%

Overall, after the closing process, all types of images experienced an increase in area, with a percentage decrease varying between 0.23% to 1.98%.

Based on the data presented, it can be seen that each type of RON 92 experienced a change in area with a different percentage decrease. It is important to note that the change in area can be related to the structure and distribution of components in the oil to understand the effect of this percentage decrease on oil quality. In general, if the reduction in area is related to the loss of unwanted components or increased fuel homogeneity, then a higher percentage can indicate an improvement in oil quality. Conversely, if the decrease in area suggests the loss of essential components that support fuel performance, a higher percentage can indicate a decrease in quality. In the context of fuels such as RON 92, homogeneity and stability of composition are very important for optimal combustion performance. Therefore, further evaluation is needed to determine whether this percentage decrease in area contributes positively or negatively to oil quality, for example, by analyzing the content of the main components before and after the process that caused the change.

3.3 Application of Histogram Technique

The histogram technique was applied in this study to analyze the pixel intensity distribution of digital images of RON 92 oil at the Pertamina Medan Tembung Gas Station. A histogram can identify changes in the pixel intensity distribution, which helps evaluate the effects of various morphological techniques applied to the image.

The first step in applying the histogram technique is to convert the original RGB image to a grayscale image. We simplify the analysis by reducing the data dimension from three channels (red, green, blue) to one intensity channel. This conversion allows for a more precise histogram visualization of the pixel intensity distribution. The example can be seen in the following image.

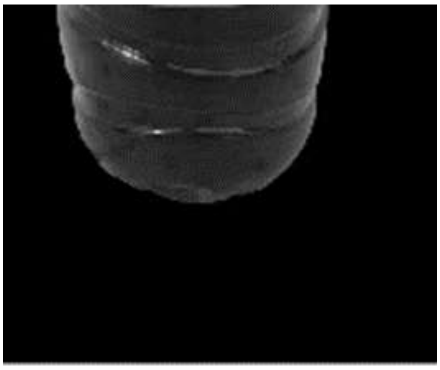

Figure 3. Grayscale Image

The histogram of the grayscale image is then calculated. This histogram is a graph that shows the frequency of occurrence of each pixel intensity level (usually in the range 0-255). At this stage, the histogram shows the initial distribution of pixel intensities before applying of morphological techniques.

After the morphological technique is applied, the histogram of the processed image is recalculated. This histogram is compared with the histogram before processing to identify changes in the pixel intensity distribution caused by the morphological technique, especially, for example dilation.

Table 2. Histogram Calculation Results

No	Average Intensity of Grayscale Image	Average Intensity of Image Dilation	Δ Average Intensity	Image Standard Deviation Grayscale	Image Standard Deviation Dilation	Δ Standard Deviation
1	15.52	21.40	5.88	27.492	37.63	10.138
2	22.73	31.16	8.43	29.31	40.31	11.00
3	20.74	27.15	6.41	32.31	41.87	9.56
4	17.86	24.19	6.33	31.26	41.29	10.03
5	36.85	45.26	8.41	46.41	55.51	9.10
6	36.12	44.38	8.26	45.60	54.89	9.29

Analysis Results:

a. Average Intensity: There is an increase in the average intensity after dilation processing in all images. This shows that the dilated images tend to be brighter than the original grayscale images.

b. Standard Deviation: The standard deviation also increases after dilation. This shows an increase in the spread of intensity values, which usually means an increase in contrast after dilation processing.

With this calculation, we can see how the dilation process affects the histogram characteristics of the grayscale image, increasing the average intensity and standard deviation, which implies an increase in brightness and contrast.

3.4 Application Testing

The following are the results of application testing when run on a matlab device. The results of the testing process from each menu in the application can be seen as follows:

a. Morphology Application Display

The display of the Ron-92 Oil Morphology Method Implementation application can be seen in **Figure 4.**

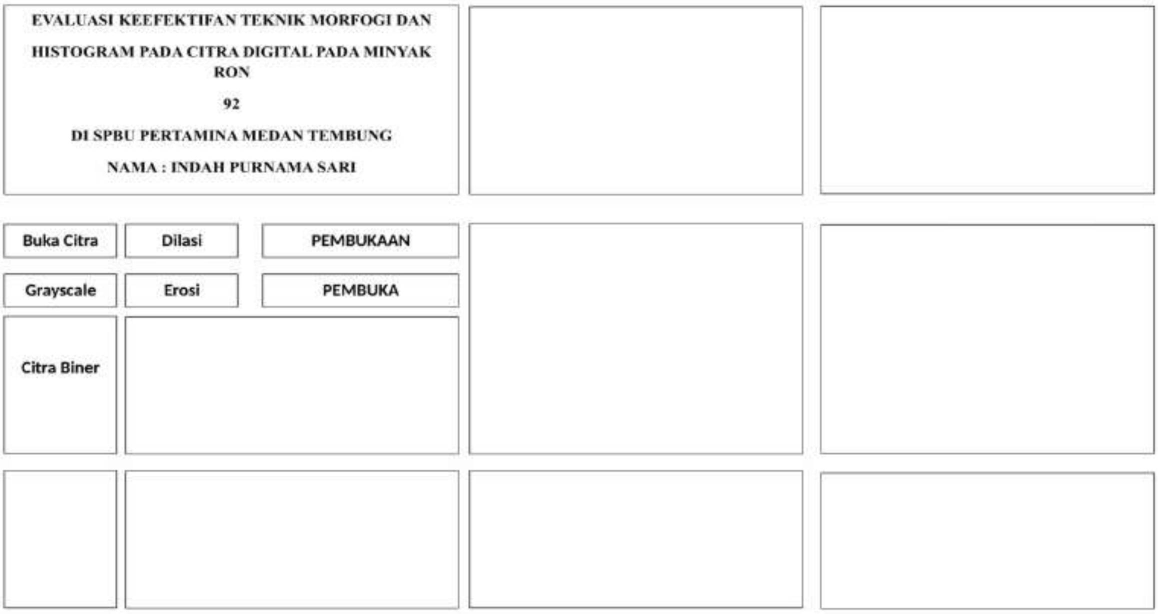

Figure 4. Morphology Application Display

Figure 4 "Morphology Application Display" refers to an image's visual presentation or output after morphological operations have been applied. Morphological operations are a set of image processing techniques that focus on the shape or structure of objects within an image, typically used on binary or grayscale images. These operations include dilation, erosion, opening, and closing, which can modify or enhance features in the image. The term "application" refers to applying these morphological techniques, and "display" refers to how the resulting image is shown or presented after the operations have been performed, often for analysis or further processing. The display highlights the changes or enhancements made to the image's structure through morphological operations.

b. Image Capture Display

The display of the image selection process to be tested using the Morphology method can be seen in **Figure 5**:

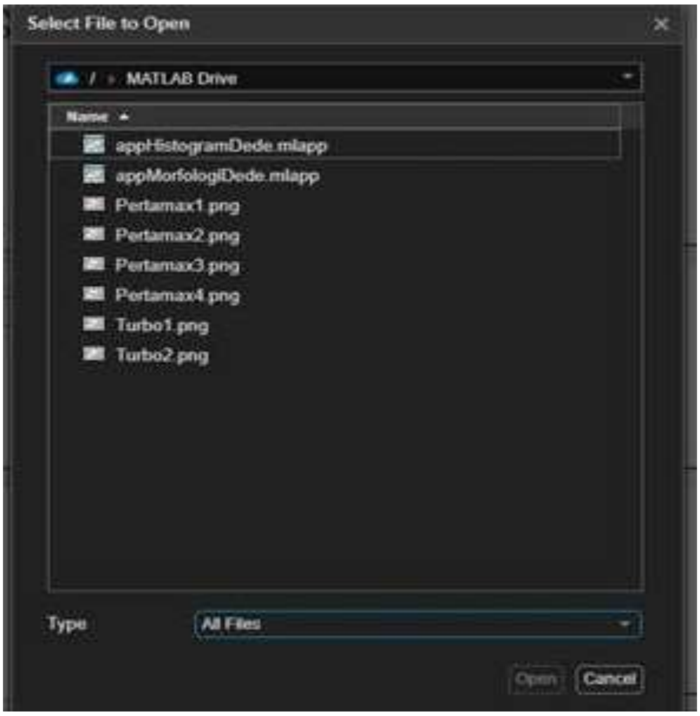

Figure 5. Image Capture Display

Figure 5 "Image Capture Display," refers to the visual presentation or output of an image that a device, such as a camera or scanner, has captured. It indicates the display of an image as it is acquired, typically showing it on a screen or monitor. This could involve the initial view of an image right after it has been captured before any processing or modifications are applied. "Capture" refers to obtaining the image. In contrast, "display" refers to how the captured image is shown for viewing, analysis, or further processing.

c. Test Image Display After Selection

The display depicting the application after the user selects the test image can be seen in **Figure 6**.

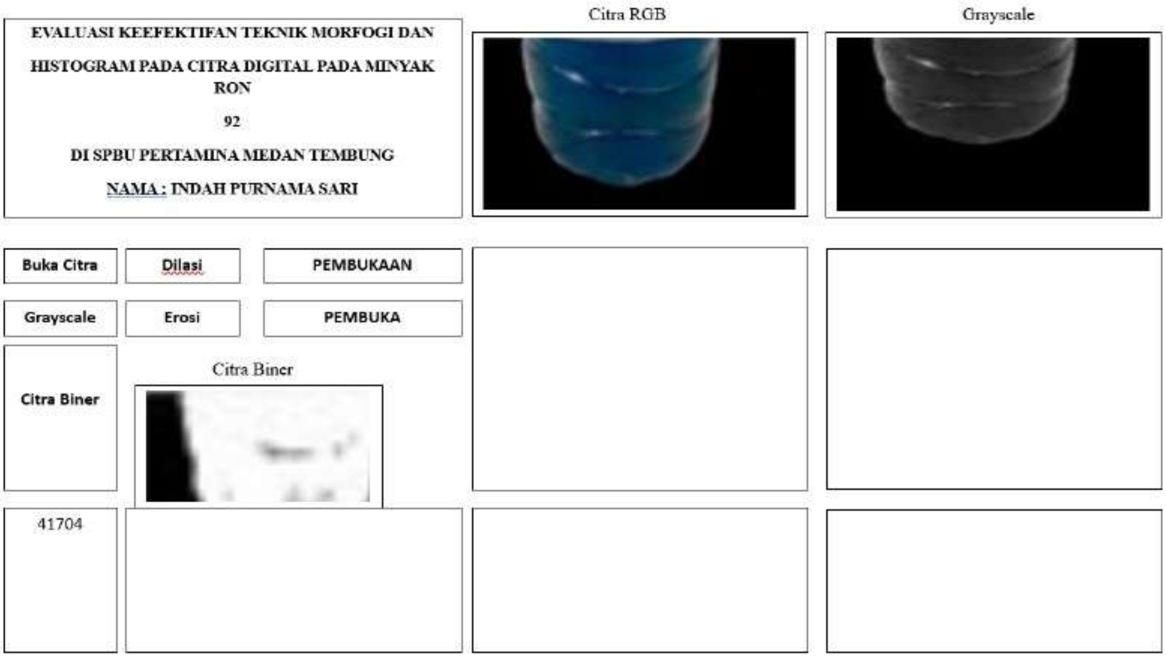

Figure 6. Morphology Test Image View After Selection

Figure 6 "Morphology Test Image View After Selection" refers to the display or visualization of an image after specific morphological operations have been applied, typically in the context of binary image processing. Morphology involves operations like dilation, erosion, opening, and closing, which modify the structure or shape of objects within the image. The term "Test Image" suggests that the image is used to test or evaluate these morphological techniques. "After Selection" indicates that a particular selection or region of interest within the image has been chosen for processing. The "view" refers to how the image appears after these morphological operations have been applied to the selected area, often to enhance or extract specific features or shapes.

d. Binary Image Processing Results Display

The display depicting the application after the user selects the dilation test image can be seen in **Figure 7.**

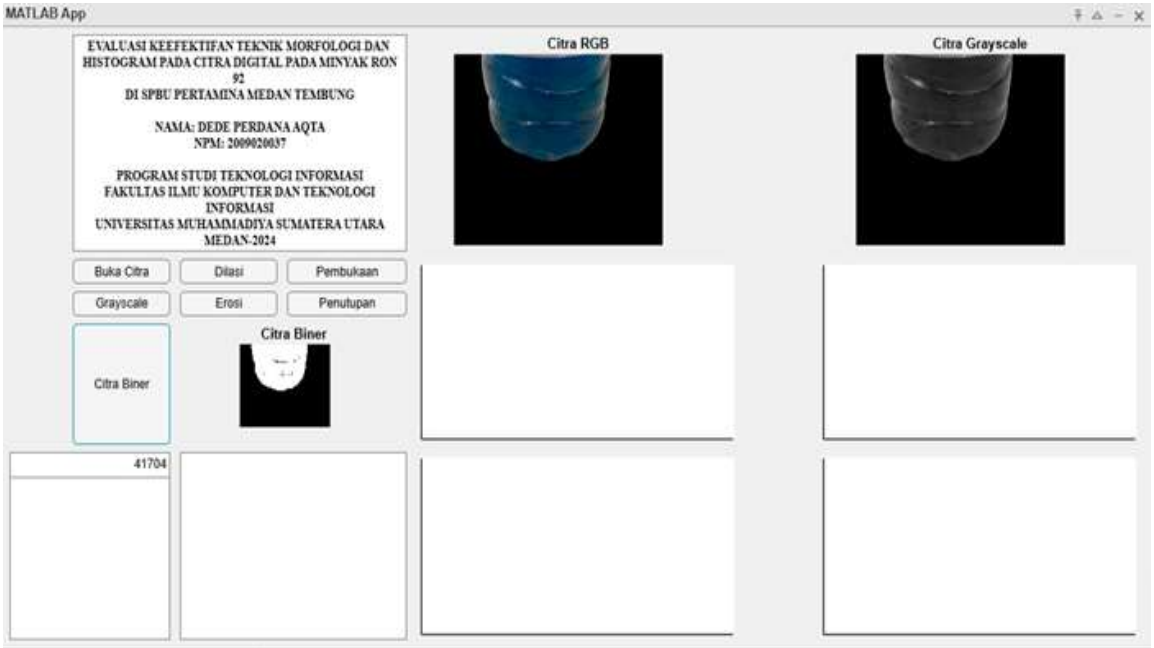

Figure 7. Binary Image Processing Result Display

Figure 7 "Binary Image Processing Results Display" refers to the visual representation or output of image processing techniques that operate on binary images. In this context, binary images consist of only two colors, typically black and white, where each pixel is represented by either a 0 (black) or a 1 (white). The results display refers to how these processed images are presented or shown after applying various image processing operations on the binary image, such as filtering, thresholding, edge detection, or object recognition. The display may include enhanced or altered versions of the original binary image to highlight specific features or results obtained from the processing algorithms.

3.5 Test Results

In the research testing, the testing process will be carried out on the images of each Arduino board product to show whether the application will produce the appropriate classification process. The test results can be seen in **Table 3**.

Table 3. Test Results

No	Image	Dilation Process	Erosin Process	Opening Process	Closing Process	Process Before Histogram	Process After Histogram
1	Pertamax 1	√	√	√	√	√	√
2	Pertamax 2	√	√	√	√	√	√
3	Pertamax 3	√	√	√	√	√	√
4	Pertamax 4	√	√	√	√	√	√
5	Pertamax Turbo 1	√	√	√	√	√	√
6	Pertamax Turbo 2	√	√	√	√	√	√

From **Table 3** above, we concluded that the application test results are running correctly.

4. CONCLUSIONS

Based on the results of our research, it can be concluded that: Effectiveness of Morphology and Histogram Techniques: Morphology and histogram techniques have proven effective in identifying the quality of RON 92 oil. The use of morphological operations such as dilation, erosion, opening, and closing allows for in-depth analysis of the structure and shape of objects in oil images. In contrast, histogram analysis provides information on the distribution of pixel intensity related to the visual quality of the oil. Application Test Results: The application testing results show that all tested RON 92 images have successfully undergone all image processing processes. This indicates that the developed application can classify and identify oil quality. Morphological operations such as dilation, erosion, opening, and closing have proven effective in highlighting the visual characteristics of oil, such as particle distribution, presence of contaminants, and homogeneity of structure. The changes in the area after morphological operations indicate the quality of the oil, whereas a more uniform distribution indicates good stability. Image histograms help assess the intensity and distribution of color in oil, which can be related to fuel content and purity. Variations in histograms before and after processing indicate structural changes that can indicate oil quality. Combining morphological and histogram techniques allows a more objective visual evaluation of RON 92 oil, although validation with conventional methods such as laboratory tests is still needed. This approach can be a tool in fuel analysis, especially in identifying inhomogeneities or contamination that can affect oil performance. Overall, this digital image-based method has the potential to be an alternative in oil quality evaluation but still requires further testing to improve its accuracy and correlation with more in-depth fuel quality parameters.

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