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# Improving Digital Image Clarity: A Study on the Application of Histogram Equalization for Noise Correction

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**Abstract:** This study aims to improve the clarity of digital images by examining the application of the histogram equalization method for noise correction. Noise in digital images is often a major challenge in maintaining the clarity and authenticity of visual information. Histogram equalization has been recognized as an effective method in improving image contrast and reducing the effects of noise. In this research, we conducted experiments by applying histogram equalization techniques to various types of digital images that are affected by noise. We analyzed the results by comparing the clarity and quality of the images before and after applying this method. The results of this research show that histogram equalization is able to significantly improve the clarity of digital images by reducing the effects of noise without sacrificing important details in the image. The implication of this discovery is the potential use of the histogram equalization method as an effective tool in improving the quality of digital images that are affected by noise.

**Keywords:** Digital image; noise; clarity; image quality; histogram equalization

## INTRODUCTION

Digital images have become one of the dominant forms of visual communication in the digital era in areas such as photography, medical processing, pattern recognition, and many more. A problem that is often encountered in digital image quality is the presence of noise, which can reduce the clarity and authenticity of visual information. Noise, in the context of digital images, can be caused by various factors, including poor quality camera sensors, signal interference during data transfer, or improper image processing. One aim of improving image quality is by reducing noise and increasing image contrast (Pardosi & Gohzali, 2022), there are many image improvement methods, one of which is histogram equalization (Hamzah & Wahyusari, 2023).

The impact of this noise can range from loss of fine detail to distortion of the entire image. To overcome these challenges, many methods have been developed to improve the clarity of digital images and reduce the effects of noise. One method that has been proven effective is histogram equalization. This method aims to even out the pixel intensity distribution in the image thereby increasing the contrast and clarity of the image. Histogram Equalization (HE) is one of the most admired and widely used contrast enhancement tips because of its accuracy and easy implementation and the results are achieved by normalizing the intensity distribution using its cumulative density function thereby increasing the contrast of the input image and the resulting image may have a uniform intensity distribution (Kurnia & Hidayat, 2023). Improving image quality is one of the image processing operations with the aim of perfecting the image, apart from that the performance of various pre-processing techniques can be used to improve image quality (Sitorus et al., 2023), (Mayangky et al., 2021). Image enhancement is one of the operations of image processing which aims to improve the image by manipulating image parameters (Fatimatuzzahro & Yuliantari, 2021).

Based on previous research conducted by Muhammad Farhan Mahfuzh in 2022 where the method used for image improvement was histogram equalization and power law gamma correction, in this research gamma was determined to be 0.7. It was found that histogram equalization had better results compared to the power law method. The results of histogram equalization have an even distribution of contrast and an even distribution of pixel frequencies, in contrast to the power law method which has a dominant distribution of pixels in black or dark (Mahfuz. M. F et al., 2022). I Putu Eka Aditya Saputra et al in 2023 compared the effectiveness of two noise reduction methods in digital images, namely histogram equalization and wavelet transformation by comparing PSNR (Peak Signal to Noise Ratio) and MSE (Mean Square Error) values using histogram equalization and wavelet transformation. The research results show that the wavelet transformation method produces higher PSNR

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values and lower MSE values compared to histogram equalization on all images tested. The best results were obtained on boat images using the wavelet transformation method which had an MSE value of 323.26 and a PSNR value of 23.04 (Fredlina, n.d.). Other research was also carried out by Rendy Galih Saputra et al using the Wiener Algorithm and Histogram Equalization. The aim of this research is to reduce noise in CCTV captured images. From the results of the experiments that have been carried out, they will be compared with ordinary noise reduction systems without Histogram Equalization. The Wiener algorithm aims to reduce noise in the image, while the Histogram Equalization aims to improve the quality of the image. From research that has been conducted, the research program has an MSE value of 1.6377 and a PSNR value of 46.0225 with a system speed of 2,956 s (Galih Saputra & Ibnu Adam, 2021).

Research conducted on cellphones by Triyo Kristantio in 2023 concluded that the Histogram Equalization method was not efficient for improving the quality of digital images, based on the RMSE and PSNR test values of images repaired using the Histogram Equalization method on all data showing RMSE values above 10, namely having This average of 27.95 shows that there is a difference from the original image data and for testing the PSNR value with an average value of 19.96 dB, which means it cannot reach the standard PSNR value of 30 dB, which shows that there is still quite a lot of noise. So it can be concluded that the Histogram Equalization method is not effective for improving image quality from old cellphones. In this context, this research aims to explore the potential of applying histogram equalization as a tool for noise correction in digital images. We will conduct an experimental study that considers different types of digital images affected by noise, focusing on the effectiveness of these methods in improving image clarity and authenticity. (Triyo Kristianto, Danar Putra Pamungkas, 2022).

Research on Histogram Equalization was also researched by Doni Setyawan et al in 2022 by acquiring digital malaria images by producing images with low contrast. This can be caused by low lighting settings on the microscope and incorrect adjustment of parameters in the image capturing software. Malaria images with low contrast can make the segmentation of erythrocytes and plasmodium from the background inaccurate. The performance of histogram-based contrast enhancement methods, namely Histogram Equalization (HE), Adaptive Histogram Equalization (AHE), and Contrast Limited Adaptive Histogram Equalization (CLAHE) was tested on malaria images to determine which method produces images with the best quality. Test results on the MP-IBD dataset, the CLAHE method gave the best results with MSE values of 482.35 and PSNR 21.62. Contrast enhancement using CLAHE can produce images with clearer visuals of erythrocytes and plasmodium and minimal noise ( et al., 2022 ).

Evaluating the improvement in digital image quality of lumbosacral radiographs using histogram equalization was researched by Guntur Winarno et al in 2022 where the image quality results showed that the histogram graphic analysis had visual brightness that increased, was evenly distributed, and the SNR value increased after being reconstructed using the histogram equalization method. VGA results using the Wilcoxon Signed-Rank test after being reconstructed using the histogram equalization method in the AP projection showed a value of 0.005 and a lateral projection of 0.074 with a p-value > 0.05 (Winarno et al., 2022).

Through this research, it is hoped that new insights can be found regarding the ability of histogram equalization to improve the quality of digital images affected by noise, as well as its practical implications in various applications. Thus, it is hoped that this research can provide a valuable contribution in the development of better and more efficient digital image processing techniques.

## LITERATURE REVIEW

The use of digital images is increasing because of the advantages they have, including ease of obtaining images, multiplying images, image processing and so on. But not all digital images have a visual appearance that satisfies the human eye. This dissatisfaction can arise due to noise, the quality of lighting in digital images that is too dark or too bright (Ade, Dadan, 2022). However, photo images often contain noise due to exposure factors that change during the printing or image taking process and make the information received not match the actual results (Dandy, Cucu, 2022). Reducing noise and increasing image contrast is part of enhancing image quality. Instead, it will impact changing the diversity of information in the image based on the value (Irpan, Hernawati, 2022).

A technique that is often used to process image quality improvements is histogram equalization, which is to produce a histogram that is uniform or even, so it is often called histogram smoothing (Fahmi, Retno, 2023). Histogram equalization is a histogram leveling process, where the distribution of image gray level values is made even (Siti, Rizky, 2021). Histogram equalization method is used to increase contrast in XRAY images using the MATLAB application (Herdy, Taufik, 2023). X-ray images improved using this method are expected to produce better contrast and brightness (Luthfi, Iwan, 2022). To increase contrast, several algorithms have been proposed, including histogram equalization (Aufi, Evi, 2021). The histogram equalization method is very effective in not only enhancing the entire image but also in enhancing texture details. This also provides completely controllable changes in the order of gray levels of the original image (Mayangky et al., 2021).

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## METHOD

The method used in this research is the Histogram Equalization method. To increase the desired clarity of digital images, the application used in this research is the Matlab application which has been widely used for image enhancement because its use is quite simple. The stages carried out by the author in applying the Histogram Equalization method include; Data Collection, Data Transformation, Data Division, Application of Histogram Equalization, and Evaluation..

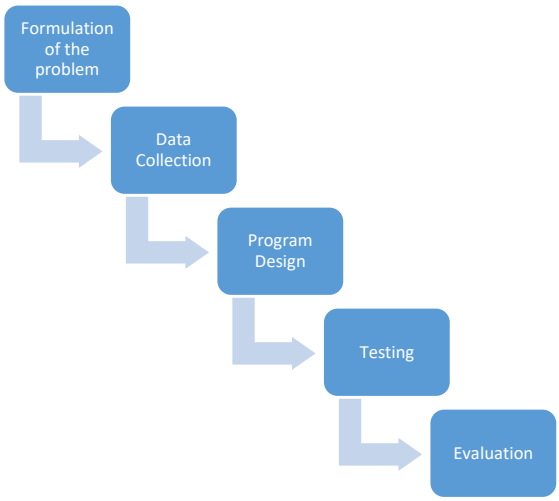


Fig. 1 Stages of Histogram Equalization

### Formulation of the Problem

Problem formulation is an important stage in research which includes identification, selection and discussion of the problem to be researched. The purpose of formulating a problem is to clarify the problem to be solved and provide a clear direction in research. At this stage questions arise regarding the process of improving the quality of fruit photo images using the histogram equalization method and the Matlab application and what the results of the enhanced images are.

### Data Collection

The next stage is data collection which includes collecting information, facts, or values from various sources that are relevant to the research objectives. Good and structured data collection is the key to producing valid and reliable research results. Data collection in this research uses fruit image data which is processed from the original image and then turned into a gray image to produce an equal histogram. The processed fruit image data includes mangosteen, grapes, pineapple and salak.

### Program Design

Program design refers to the process of planning the structure, function and workflow of a computer program before starting the implementation or coding process. The role of the program carried out in this research went through two stages. The first stage is to create a program design using GUI tools in Matlab. The second stage is the result of a program design that has been designed using GUI tools in Matlab.

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HE_buah.m

```
% Baca gambar
gambar_asli = imread('manggis.jpg');

% Konversi gambar ke dalam skala keabuan jika diperlukan
if size(gambar_asli, 3) == 3
    gambar_keabuan = rgb2gray(gambar_asli);
else
    gambar_keabuan = gambar_asli;
end

% Hitung histogram gambar asli
hist_asli = imhist(gambar_keabuan);

% Hitung jumlah piksel dalam gambar
jumlah_piksel = numel(gambar_keabuan);
```

Fig. 2 GUI tools in Matlab

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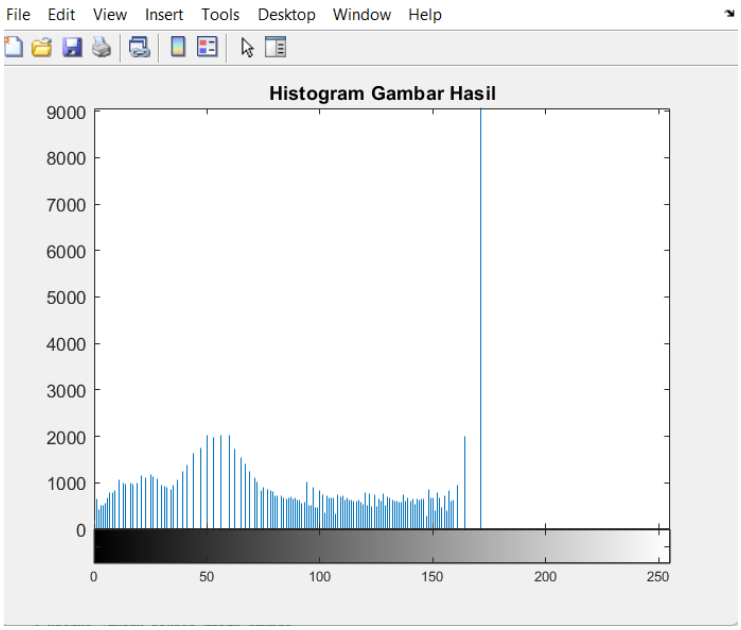


Fig. 3 Result Image Histogram

**Testing**

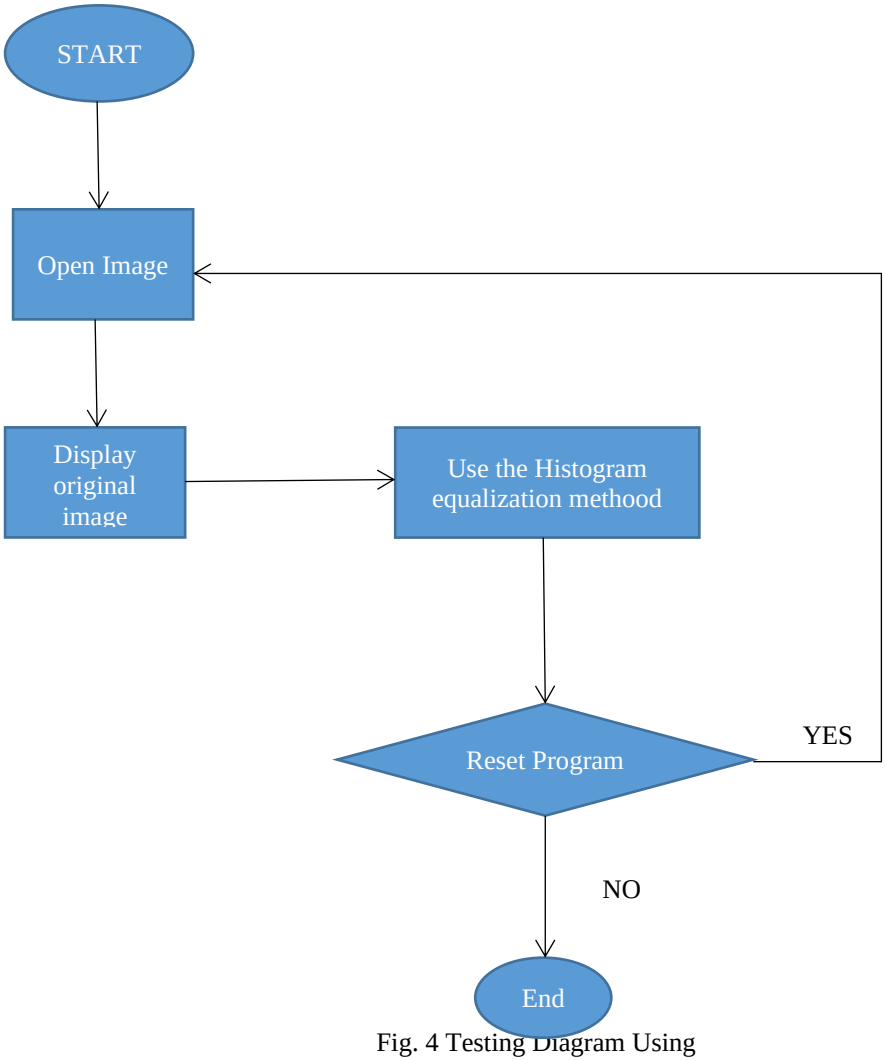


Fig. 4 Testing Diagram Using

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Testing is carried out by entering examples of fruit photos whose quality you want to improve and then processing them using the Histogram Equalization method in the Matlab application, then if the test is not optimal you can open another photo of fruit after the program is reset first, and if the test is deemed optimal then the test can be completed immediately.

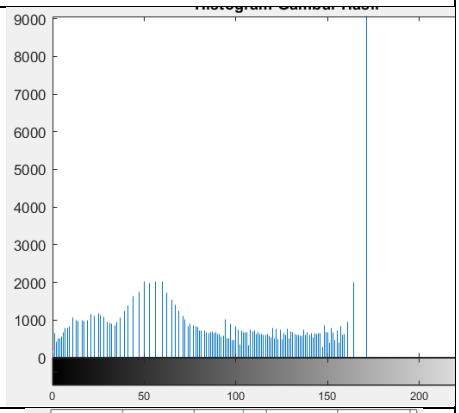
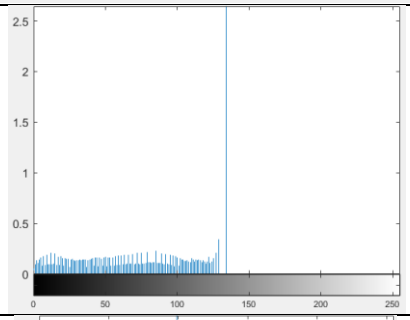
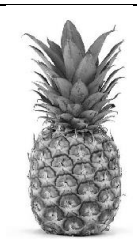
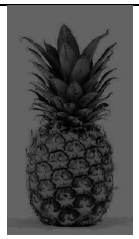
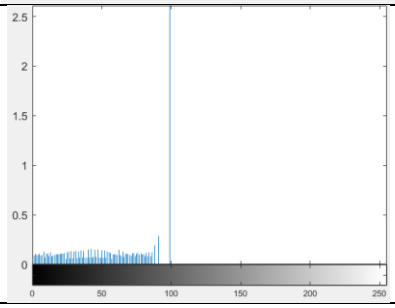
**Evaluation**

There are three stages of analysis carried out, namely analysis of the original image, then gray image and histogram analysis. The results of image analysis are comparing photos of real fruit with photos of fruit after processing with a histogram. Histogram analysis by comparing the shape of the histogram of the original fruit photo with the photo of the fruit after processing.

## RESULT

Photos of fruit obtained from the internet. The extension for this fruit photo is JPG. This photo shows a GUI program in MATLAB that has been well designed. This program aims to carry out analysis of the data that has been obtained. This program has an easy-to-use design so researchers can easily enter data, activate program features, and see analysis results clearly.

The following are the results of histogram equalization :

| Name Image | Original Image | Gray Image | Histogram Equalization Results | Result Image Histogram |
|---|---|---|---|---|
| Mangosteen |  |  |  |   |
| Grape |  |  |  |   |
| Pineapple |  |  |  |   |

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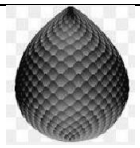
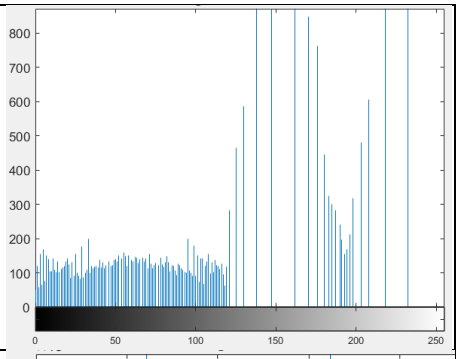
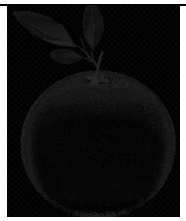
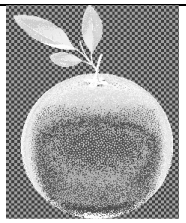
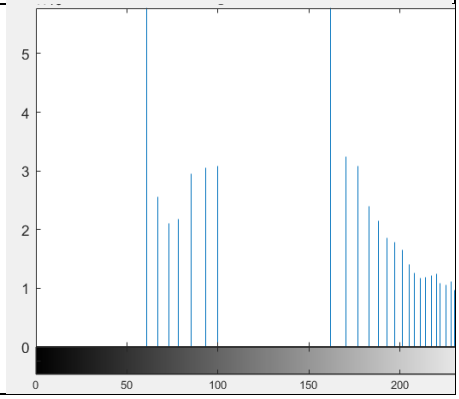
| | | | | |
|---|---|---|---|---|
| Snakefruit |  |  |  |  |
| Orange |  |  |  |  |

Table. 1 Result

Test analysis using Histogram Equalization is an image processing method to increase image contrast and clarity. Histogram Equalization is a technique used to even out the pixel intensity in an image, changing the original histogram into an even histogram. In this photo you can see the testing process using Histogram Equalization on an image. The image may have lower contrast or uneven intensity. The aim of this analysis is to increase the clarity and contrast of the image so that details can be seen more clearly.

## DISCUSSIONS

See in Table 1 the results of comparing the image with the original image on the left, there may be some objects that are less clear. However, if processed with Histogram Equalization it produces an image that has better contrast and even pixel intensity throughout the image. Details that were previously difficult to see, such as the edges of objects or fine textures, are now clearer and better visible. In the Histogram Equalization process, a pixel histogram is calculated from the original image, where the distribution of pixel intensity values is represented in graphical form. Then the histogram is adjusted by changing the pixel intensity values so that the resulting histogram is even. This is done by applying an appropriate transformation function to each pixel in the image.

The advantage of the Histogram Equalization method in processed images is that this method can add contrast and light to the image and can even out gray areas which makes the image can be said to be good, even though there are weaknesses such as contrast and brightness. The image can still be improved, but for this fruit photo this method is enough to show the image due to noise. In previous research, this method was used to improve image quality with different objects. The results of previous research were considered less than optimal so further research was needed. This research program already exists and tests it with different objects from previous research. Once developed, this new program can improve image quality to the maximum and produce new images with better quality

Brightening the quality of the image can also be done using gamma correction with the aim of easily detecting edges in the image, such as in underwater images. This is done because often the problem faced is the occurrence of a lot of noise, such as lighting, water ripples (water waves) and water turbidity. Improvement of an image can be done with point operation. One of the methods in point operation is gamma correction.

## CONCLUSION

Based on the research that has been carried out, it can be concluded that the Histogram Equalization method can and is well used to improve the quality of fruit photo images. The results of this research can be seen by comparing images before and after processing and comparing the histograms. This research produces better quality fruit photos. In addition to histogram equalization, other methods such as gamma correction can also be used for

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noise correction in point operations, where each method has its own advantages according to its purpose. The image used can also be done on medical images to help in getting better results on noise correction.

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