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IMPLEMENTATION OF CONVOLUTION MATRIX AND PSNR ON BRAIN TUMOR IMAGE

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Abstract

Brain Tumor is a deadly disease that affects both men and women in this life. Detection of brain tumors can be using CT scan (Computed Tomography scan) and Magnetic Resonance Imaging (MRI). In this study took 5 brain images from CT scans and processed into 25 images. The algorithm used is 3x3 kernel Matrix Convolution and 5x5 kernel for image sharpening and blurring, after which the values of MSE, RMSE and PSNR will be obtained. The best result of convolution 3 brain tumor image obtained from the image input image sharpening kernel 3x3 is the first, the image input 5 with the value of MSE 1308.597034, RMSE 36.174536 and PSNR 16.962744 dB. Second, with the input image 3 with the value of MSE 1316.962532, RMSE 36.289978 and PSNR 16.935069 dB. Third, the input image 1 with the value of MSE 1325.889702, RMSE 36.412768 and PSNR 16.905730 dB. The best result of convolution 3 brain tumor image obtained from the input image blurring kernel 5x5 is the first, the input image 5 with the value of MSE 2235.845032, RMSE 47.284723 and PSNR 14.636387 dB. Second, with the input image 4 with the value of MSE 2291.064041, RMSE 47.865061 and PSNR 14.530431 dB. Third, the input image 3 with the value of MSE 2292.273529, RMSE 47.877693 and PSNR 14.528139 dB.

Keywords: Matrix Convolution, Image Sharpening And Blurring, PSNR, Brain Tumor, CT Scan

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INTRODUCTION

The human brain is a structure that plays an important role in life. This Organ is located at the highest part of the human body organs equipped with protection using skull bones and is a controlling parent, where the ability is possessed in regulating how a person performs activities as a human being (Arief Wisky & Sumijan, 2022).

Brain tumors are deadly diseases and can affect anyone. Brain tumors rank 10th as a cause of death in both men and women. The mortality rate (number of deaths) due to brain tumors is 4.25 per 100,000 inhabitants per year (Mutiara & Azizah, 2022).

Tumors in the brain can be detected through Magnetic Resonance Imaging (MRI). After the patient undergoes the examination process, the radiology specialist will analyze and draw conclusions from the images produced by the medical device (Winnarto et al., 2022). MRI is the best radiology equipment to diagnose brain cancer that is complex and of varying intensity. The advantages of MRI include being able to get high-resolution images, which are applied to the brain organs because they do not contain ionizing radiation but iterprestasi or reading MRI images takes a long time. So Image Segmentation needs to be done image segmentation aims to divide the tumor image area and the normal area (Armansyah, 2022).

Detection of brain tumors can also be using a CT scan (Computed Tomography scan). CT-Scan is one of the diagnostic methods commonly used in the medical world. CT scans provide detailed images of brain structures and can help identify the presence of tumors.

A common Matrix convolution in CT-scans is the application of a convolution filter or kernel for a specific purpose. Matrix convolution used on license plates rely on three derived images, namely X, Y, and XY, and image convolution using Prewitt operator. The image is then blurred with a Gaussian operator to slightly blur the image (Ulmiah Muis et al., 2023).

Testing 7 fish meat images by comparison of two methods in which the robert method produces a clearer edge detection compared to the convolution method (Putri et al., 2023), (Algama et al., 2023).

Face detection using canny algorithm with the purpose of detecting, the lines that make up the object in the original image through convolution approach of image matrix and Gaussian operator. The results of facial detection from this study are in the form of hysteresis Low Threshold and hysteresis High Threshold facial sketch. The advantage of this Canny edge detection is the ability to reduce noise before performing edge detection calculations (Rikky et al., 2023), (Munandar et al., 2021), (Setyawan & Nawansari, 2022).

The Marr-Hildert method can be used well to find the detection results of the fat region boundary by the process of generating kernel values and the conversion process to grayscale image samples that are used as objects (Rajagukguk, 2022), (Faradilla et al., 2022).

This study used 8 algorithms for noise reduction, using 2 types of noise, using RGB (true color) images, using 3x3 Matrix Convolution and using a mathematical measurement for comparison of the algorithms used (Nugroho & Hazmin, 2022).

Identification of edge detection in face patterns applies sobel, roberts and prewitt methods. The results of the three methods

are that the sobel method produces an image outline that shows a clearer pattern and is in accordance with the original image (Novia, 2022), (Restuning Pamuji & Putra Pamungkas, 2023), (Putra Assyakur et al., 2022).

RESEARCH METHODS

This study introduces a new approach to Matrix convolution with 3x3 and 5x5 kernels for image sharpening and image smoothing, then the value of Mean Square Error (MSE), Root Mean Squared Error (RMSE), and Peak Signal-to-Noise Ratio (PSNR) will be searched. Figure 1 below shows the research framework of this study:

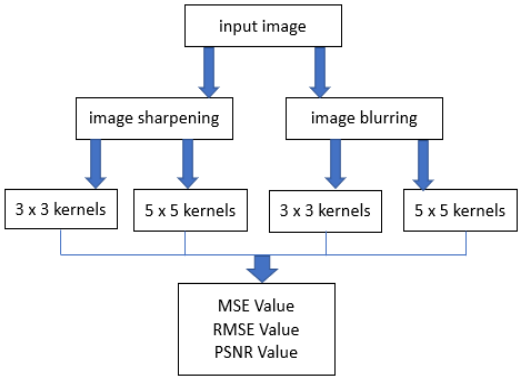


Figure 1. Research Framework

Input Image

The images used in this study are 5 images of brain tumors obtained from the data of the General Hospital Center M.Djamil field with 512x512 pixels. After the execution of each image will produce 25 images to sharpen the image and blur the image. From this condition, it will be seen which image is better in the process of sharpening and blurring the image from the original image.

Image Sharpening

Image sharpening is the process of sharpening the image of a brain tumor by using 3x3 kernels and 5x5 kernels. For 3x3 kernels use convolution Matrix values.

$$h = \begin{bmatrix} 1 & 1 & 1 \\ -1 & 3 & -1 \\ -1 & -1 & -1 \end{bmatrix}$$

For 5x5 kernels use convolution Matrix values.

$$\mathrm{h} = \begin{bmatrix} -1 & -1 & -1 & -1 & -1 \\ -1 & -1 & -1 & -1 & -1 \\ 1 & 1 & 25 & 1 & 1 \\ -1 & -1 & -1 & -1 & -1 \\ -1 & -1 & -1 & -1 & -1 \end{bmatrix}$$

The Kernel affects the quality of image sharpening. 5x5 kernels tend to recognize more complex edges and smoother contours than 3x3 kernels. 5x5 Kernel can store more image detail, especially regarding finer and smaller features in brain images. 5x5 kernels tend to have a stronger smoothing effect than 3x3 kernels because their larger size means that 5x5 kernels can eliminate noise in the image more effectively. Using 5x5 kernel requires more computation than 3x3 kernel because more elements have to be processed. This can have an impact on the processing time and performance of convolution algorithms, especially in the context of medical image processing that requires rapid analysis.

Image Blurring

Image blurring is the process of blurring the image of a brain tumor by using 3x3 kernels and 5x5 kernels. For 3x3 kernels use convolution Matrix values.

$$h = \left(\frac{1}{49}\right) * \begin{bmatrix} 5 & 7 & 5 \\ 7 & 7 & 7 \\ 5 & 7 & 5 \end{bmatrix}$$

For 5x5 kernels use convolution Matrix values.

$$h = \left(\frac{1}{25}\right) * \begin{bmatrix} 1 & 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 & 1 \end{bmatrix}$$

The 3x3 Kernel has a smaller convolution area, so the blurring effect is lighter than the 5x5 kernel. The 5x5 Kernel produces stronger and significant blurring because it can reduce more detail in the brain image than a 3x3 kernel. In brain image processing, the 5x5 kernel can also reduce details that may be very important. The 5x5 Kernel might be a better choice if it reduces noise without sacrificing too much detail. In contrast, a 3x3 kernel is better if you want to keep as much detail in the image as possible while still reducing noise.

MSE, RMSE, PSNR

MSE, RMSE, and PSNR values are required to determine the quality of the selected image. MSE is a measure of the average error between two datasets, RMSE is the square root of MSE, and PSNR is a commonly used measure to measure the quality of processed or compressed images (Pourasad & Cavallaro, 2021). The smaller the value of MSE and RMSE, the better the Psnr value. The higher the PSNR value of the selected image, the better the image quality.

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

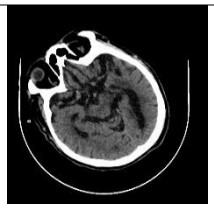
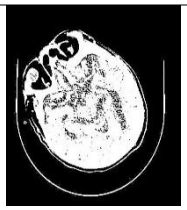
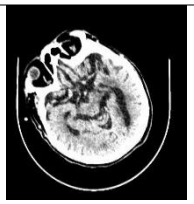
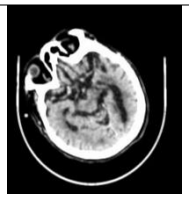
$$RMSE = \sqrt{\frac{1}{m\,x\,n} \sum_{i=0}^{n-1} \sum_{j=0}^{m-1} [f(i,j) - g(i,j)]^2} \quad (2)$$

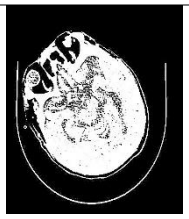
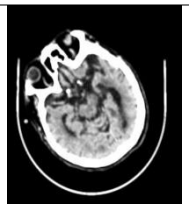
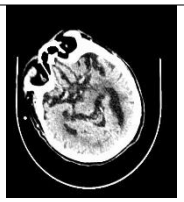
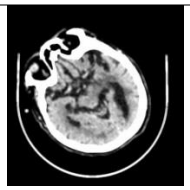
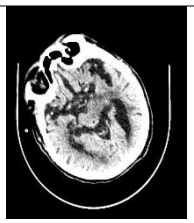
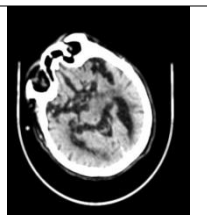
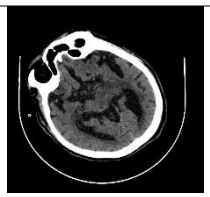
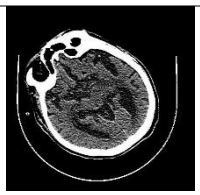
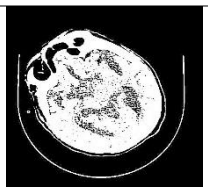
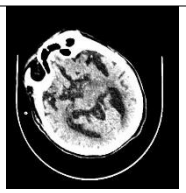
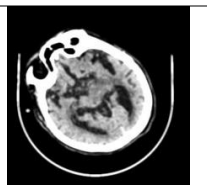
Variables m and n are the dimensions of the mind to be processed. The value of f (i,j) is the pixel value of the original image at coordinates (i,j). The value of g (i,j) is the pixel value of the improved image at the coordinates (i,j).

$$PSNR = 10 \log 10 \frac{255^2}{MSE} \quad (3)$$

RESULTS AND DISCUSSION

In this subsection, we describe the results obtained at each procedural stage and further engage in a comprehensive discourse on the previously described results. Research results, including the resulting image goes through different phases, taking the image in, sharpening the image, blurring the image, and the final result.

No	Input Image	Image Sharpening		Image Blurring	
		3x3 kernels	5x5 kernels	3x3 kernels	5x5 kernels
1					

No	Input Image	Image Sharpening		Image Blurring	
		3x3 kernels	5x5 kernels	3x3 kernels	5x5 kernels
2					
3					
4					
5					

Tabel 1. Image Sharpening dan image blurring

From the table above it is shown that the input image that undergoes image sharpening and image blurring changes according to the convolution value of the given matrix. The image of 3x3 kernel is better than 5x5 kernel, while the image of 5x5 kernel is better than 3x3 kernel. The results of the image obtained will be evidenced by the value of MSE, RMSE and PSNR of image sharpening and image blurring in Table 2.

Image	MSE Value	RMSE Value	PSNR Value
Image Sharpening 1 (3x3)	1325.889702	36.412768	16.905730 dB
Image Sharpening 1 (5x5)	6202.583492	78.756482	10.205077 dB
Image Blurring 1 (3x3)	2575.917213	50.753495	14.021485 dB
Image Blurring 1 (5x5)	2295.829327	47.914813	14.521408 dB
Image Sharpening 2 (3x3)	1345.075485	36.675271	16.843337 dB
Image Sharpening 2 (5x5)	6180.336452	78.615116	10.220682 dB
Image Blurring 2 (3x3)	2615.198029	51.139007	13.955758 dB
Image Blurring 2 (5x5)	2326.461056	48.233402	14.463846 dB
Image Sharpening 3 (3x3)	1316.962532	36.289978	16.935069 dB
Image Sharpening 3 (5x5)	6172.200100	78.563351	10.226404 dB
Image Blurring 3 (3x3)	2576.607529	50.760295	14.020321 dB
Image Blurring 3 (5x5)	2292.273529	47.877693	14.528139 dB
Image Sharpening 4(3x3)	1329.560852	36.463144	16.893721 dB
Image Sharpening 4 (5x5)	6243.458668	79.015560	10.176551 dB
Image Blurring 4 (3x3)	2564.566078	50.641545	14.040665 dB
Image Blurring 4 (5x5)	2291.064041	47.865061	14.530431 dB
Image Sharpening 5 (3x3)	1308.597034	36.174536	16.962744 dB
Image Sharpening 5 (5x5)	6270.010651	79.183399	10.158121 dB

Image	MSE Value	RMSE Value	PSNR Value
Image Blurring 5 (3x3)	2486.875515	49.868582	14.174263 dB
Image Blurring 5 (5x5)	2235.845032	47.284723	14.636387 dB

Tabel 2. Nilai MSE, RMSE dan PSNR

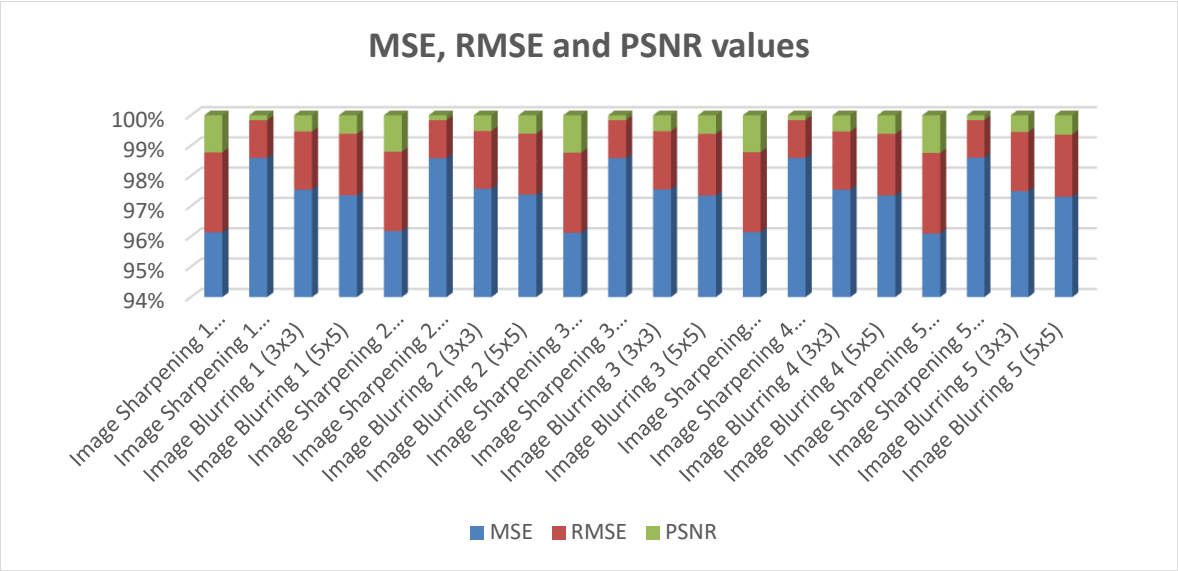


Figure 2. Graph of MSE, RMS and PSNR values

Based on Table 2 above, it is shown that the highest value in the sharpening image is obtained from image 5 (3x3) as evidenced by the values MSE = 1308.597055, RMSE = 36.174536 and PSNR = 16.905730 dB. The highest value in the defocus image is obtained from image 5 (5x5) with proven values of MSE = 2235.845032, RMSE = 47.284723 and PSNR = 14.636387 dB.

Figure 2 shows a visualization of the MSE, RMSE and PSNR values of image blurring and image sharpening for 3x3 and 5x5 kernels from the results of Table 2.

CONCLUSION

The best result of convolution 3 brain tumor image obtained from the image input image sharpening kernel 3x3 is the first, the image input 5 with the value of MSE 1308.597034, RMSE 36.174536 and PSNR 16.962744 dB. Second, with the input image 3 with the value of MSE 1316.962532, RMSE 36.289978 and PSNR 16.935069 dB. Third, the input image 1 with the value of MSE 1325.889702, RMSE 36.412768 and PSNR 16.905730 dB. The best result of convolution 3 brain tumor image obtained from the input image blurring kernel 5x5 is the first, the input image 5 with the value of MSE 2235.845032, RMSE 47.284723 and PSNR 14.636387 dB. Second, with the input image 4 with the value of MSE 2291.064041, RMSE 47.865061 and PSNR 14.530431 dB. Third, the input image 3 with the value of MSE 2292.273529, RMSE 47.877693 and PSNR 14.528139 dB.

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