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EFFECTIVENESS EDGE DETECTION OPERATOR CANNY TO IMPROVE IMAGE QUALITY THORAX CT SCAN IN CASES COVID-19

EFEKTIVITAS METODE PENDETEKSIAN TEPI OPERATOR CANNY DALAM UPAYA PENINGKATAN KUALITAS CITRA CT SCAN THORAX KASUS COVID-19

Research Report
Penelitian

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ABSTRACT

Background: *Thorax CT scan is one of the medical supports that contributes most importantly to the diagnosis, especially cases of COVID-19. The disadvantage that has a CT scan image is noise. When the noise is high then the Signal Noise Ratio (SNR) value produced is low. Canny operator edge detection technique is one solution to animate noise.* ***Purpose:*** *Analyzing differences in image quality and anatomical information on thorax CT scan images in COVID-19 patients before and after the application of canny operator edge detection techniques.* ***Method:*** *A quasi experimental research on thorax CT Scan images before and after the application of canny operator edge detection which amounted to 10 samples. Image assessment is done by measuring noise, SNR, and anatomical information. Differences in image quality (noise and SNR) are tested with Paired T-tests. Anatomical information is tested with the Wilcoxon Signed Rank Test.* ***Result:*** *There are differences in image quality in thorax CT scan images in COVID-19 patients before and after the application of canny operator edge detection techniques, with p-value <0.001. There are differences in the anatomical information of thorax CT scan images in COVID-19 patients before and after the application of canny operator edge detection technique with a p-value of 0.004.* ***Conclusion:*** *Edge detection operator canny techniques are able to lower noise values, improve SNR and improve image anatomy information thorax CT scan in COVID-19 patients.*

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ABSTRAK

Latar belakang: Pemeriksaan CT scan thorax adalah salah satu penunjang medis yang memberikan kontribusi penting untuk diagnosis terutama kasus COVID-19. Kelemahan yang dimiliki pada citra CT scan adalah *noise*. Apabila noise tinggi maka nilai *Signal Noise Ratio* (SNR) yang dihasilkan rendah. Teknik teknik deteksi tepi operator canny merupakan salah satu solusi untuk meminimalisir *noise*. **Tujuan:** Menganalisis perbedaan kualitas citra dan informasi anatomi pada citra CT scan thorax pada pasien COVID-19 sebelum dan sesudah penerapan teknik deteksi tepi operator canny. **Metode:** Penelitian quasi eksperimen citra CT scan thorax sebelum dan sesudah penerapan deteksi tepi operator canny yang berjumlah 10 sampel. Penilaian citra dilakukan dengan mengukur *noise*, SNR, dan informasi anatomi. Perbedaan kualitas citra (*noise* dan SNR) dilakukan pengujian dengan *Paired T-Test*. Informasi anatomi diuji dengan *Wilcoxon Signed Rank Test*. **Hasil:** Terdapat perbedaan nilai *noise* dan SNR citra CT scan thorax pada pasien COVID-19 sebelum dan sesudah penerapan teknik deteksi tepi operator canny dengan *p-value*<0,001 (penurunan *noise* 1,226 dan peningkatan SNR 0,136). Terdapat perbedaan informasi anatomi citra CT scan thorax pada pasien COVID-19 sebelum dan sesudah penerapan teknik deteksi tepi operator canny dengan *p-value* 0,004. **Kesimpulan:** Teknik deteksi tepi operator canny mampu menurunkan nilai *noise*, meningkatkan SNR dan meningkatkan informasi anatomi citra CT scan thorax pada pasien COVID-19.

Kata kunci:
Canny, COVID-19, Deteksi tepi, CT scan thorax

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INTRODUCTION

Radiographic examinations carried out in cases of COVID-19 initially use a lot of thorax X-Ray. The drawback of this examination is that it only shows bilateral infiltrates and usually shows a normal picture at the start of the disease symptoms. Therefore, a thorax CT scan was carried out to complete the further information on patients with COVID-19 cases (Bhatt *et al*., 2021; Ye *et al*., 2020). The Chinese National Health Center Commission said that as many as 98% could show sensitivity on a thorax CT scan in COVID-19 patients (Ahuja *et al*., 2021; Ai *et al*., 2020), by carrying out a thorax CT scan examination in COVID-19 patients. The progress of the disease can be monitored and evaluated.

Excellence in thorax CT scan examination can show and evaluate disease development sensitivity. While the deficiencies in the CT scan thorax examination, the resulting image has a high noise level (Sejati and Nurbaiti, 2021). Image quality on a CT scan is characterized by low noise and high *Signal Noise Ratio* (SNR). One of the methods to reduce noise and increase the SNR is the canny operator edge detection method (Punarselvam and Suresh, 2011)

Edge detection is performed to detect the edge line that delimits two homogeneous image regions with different brightness levels. Edge detection in images is a process that produces the edges of an image object to mark image details, repair blurred image details that occur due to errors or during the acquisition process, and convert 2D images into curves (Suryaningsih, 2012). Four edge detection operators are Sobel, Prewitt, Robert, and Canny. In edge detection, the Sobel operator will enhance and detect image edges with 2D spatial derivatives in an image. The Prewitt operator is a development of the Robert operator with the *High Pass Filter* (HPF) technique (Trisnawati and Hakim, 2018).

In contrast, the Robert operator is a differential technique developed in the horizontal and vertical directions with binary conversion processes. The canny operator edge detection method is the most optimal edge detection. The canny operator uses the Gaussian Derivative Kernel to filter the initial image for smooth edge detection (Suryaningsih, 2012).

Previous studies have described the application of the edge detection method with the canny operator in improving image quality on thorax CT scans based on wavelet transformation due to the influence of noise (Bhadauriah *et al*., 2013). Another study used edge detection with the Roberts, Prewitt, Sobel, and Canny operators on thorax CT scan images with wavelet package decomposition through the *Matlab* (Sun and Wang, 2011). Meanwhile, other studies explain the edge detection used in thorax CT scan images with canny operators and morphological operations (Noviana *et al*., 2017). Further research uses edge detection with the canny operator on a quantum-based thorax CT scan to produce gradient quantities by observing the strength of pixel values (Widiyanto *et al*., 2018). In comparison, other studies used edge detection with the canny operator on thorax X-ray images of pneumonia cases with high sensitivity, specificity, and accuracy (Hwa *et al*., 2020).

This research is based on the constraints experienced on a 16-slice CT scan owned at RSUD dr. Soeselo Slawi still needs to get special software to reduce existing noise, for example iterative reconstruction. This research will be carried out by processing thorax CT scan images in COVID-19 case patients using the edge detection method with the canny operator. Canny operator edge detection is optimal for detecting the boundaries of thorax CT scan images, which aim to reduce noise and increase the SNR to obtain informative images from thorax CT scan images in COVID-19 patients (Amalia and Budhi, 2020; Na'am *et al*., 2016). Thorax CT scan images were taken on coronal slices due to convenience in research based on several existing journals. Based on these problems, researchers will conduct research to examine the differences in CT scan thorax images of coronal sections without edge detection (original image/raw data) with CT scan thorax images of coronal sections which are treated in the form of using edge detection methods with the canny operator and the expected results this research can help improve the quality of COVID-19 diagnosis in Radiology.

MATERIAL AND METHOD

This type of research is quasi-experimental with a pre and post-test design. The sample used is the results of thorax CT scan images of the COVID-19 case that already exists on the CT scan workstation. The sampling technique used was the purposive sampling method (Sugiyono, 2011). A retrospective sampling of 10 samples in each treatment group using the edge detection method (Canny operator). The results of the thorax CT scan image of the COVID-19 case were carried out anonymized (hiding the identity of the sample). Next, the image is exported for treatment as an edge detection application with *Matlab*. The image was assessed before and after treatment using quantitative assessment by measuring noise and SNR. Qualitative assessment was carried out with an anatomical information assessment questionnaire to radiologists. Data were analyzed using SPSS.

Data from the results of noise and the SNR measurements were tested using the *Paired T-test* to determine the strength of the relationship between before and after treatment, the effect size was measured using *Cohen's d test* (Fessler, 2008). Two respondents carried out data from the image assessment questionnaire results. The results of the questionnaire assessing the anatomical information obtained are in the form of data with an ordinal scale which will be interpreted with a score. It consists of scores 1, 2, 3, and 4, which indicate the level of answers. The data are tabulated to determine the difference between before and after the treatment and the optimal image results. Then the data were analyzed using the *Wilcoxon Signed Rank Test* on SPSS.

RESULT

Noise

Based on the results of the different test with the *Paired T-Test* on noise the results can be seen in Table 1 that the significance value (2-tailed) <0.001 (*p-value*<0.05), so it can be seen that the noise value of thorax CT scan images in COVID-19 patients before and after the application of the canny operator edge detection technique has a significant difference (means).

Table 1. Noise value difference test results

	Noise before treatment	Noise after treatment	
N	10	10	
Means	12.164	10.938	1.226
SD	0.865	0.816	
Sig. (*p-value*)	< 0.001		
Inform.	There is a difference		
Cohen's d	1.45		
Effect size	Very large		

The mean (Table 1) shows a positive value (1.226), which means there is a tendency to decrease the noise value after treatment. The average decrease is 0.0329. Based on the effect size test results, *Cohen's* d is 1.45, so it can be seen that the strength of the relationship between the noise value of thorax CT scan images in COVID-19 patients before and after the application of the canny operator edge detection technique has a considerable effect size (Sawilowsky 2009; Qin, 2020).

SNR

Based on the results of the different test with the *Paired T-Test* on SNR can be seen in Table 2. It shows that the significance value (2-tailed) <0.001 (*p-value*<0.05), so it can be seen that the SNR value of thorax CT scan images in COVID-19 patients before and after the application of the edge detection technique operator canny there is a significant difference (mean).

Table 2. SNR value difference test results

	SNR before treatment	SNR after treatment	
N	10	10	
Means	1.251	1.387	- 0.136
SD	0.155	0.167	
Sig. (*p-value*)	< 0.001		
Inform.	There is a difference		
Cohen's d	0.84		
Effect size	Large		

The mean (Table 2) shows a negative value (-0.136), which means there is a tendency to increase the SNR value after treatment. The average increase is 0.0054. Based on the effect size test results, *Cohen's d* is 0.84, so it can be seen that the strength of the relationship between SNR values of thorax CT scan images in COVID-19 patients before and after the application of the canny operator edge detection technique has a significant effect size (Sawilowsky, 2009).

Anatomical information

Based on the results of the different test with the *Wilcoxon Signed Rank Tes*t on anatomical information obtained results can be seen in Table 3.

Table 3. Noise value difference test results

	inform. Anatomy before treatment	inform. Anatomy after treatment
N	10	10
Means	9.00	13.70
SD	2.944	3.401
Sig. (*p-value*)	< 0.004	
Inform.	There is a difference	

Based on the results of the different tests for assessing the anatomical information in Table 3. It shows that the significance value (2-tailed) is 0.004 (*p-value* <0.05), so it can be seen that the anatomical information on thorax CT scan images in COVID-19 patients before and after the application of the operator's edge detection technique canny there is a significant difference (mean). Figure 1 shows thorax CT scan images in COVID-19 patients before and after the application of the operator's edge detection technique canny.

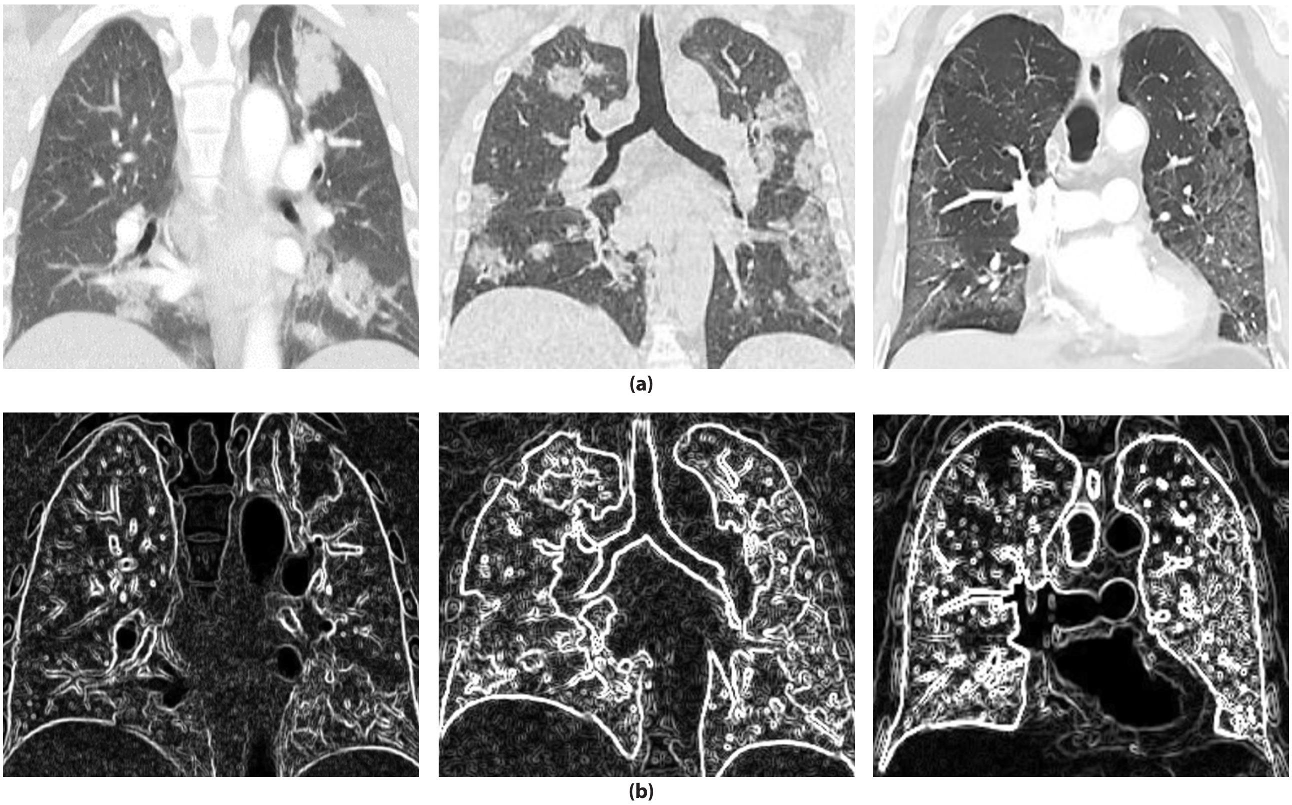

Figure 1. Example of thorax CT scan image results for COVID-19 patients in the study. (a) Before treatment application of canny operator edge detection techniques; (b) After treatment application of the canny operator edge detection technique

DISCUSSION

The test results show that the noise value generated on the thorax CT scan image of COVID-19 patients after applying the canny operator edge detection technique has decreased noise. This is in accordance (Table 1) with the measurement data before treatment which is 12.164 and after treatment is 10.938. Noise or noise is the CT number value fluctuation (Standard Deviation) in homogeneous tissue or material, for example water has a CT number of 0. The higher the standard deviation of the CT number in measurements at water points, the higher the noise (Seeram *et al*., 2013). Noise will affect the resolution contrast. The higher the noise, the lower the resolution contrast (Bushberg *et al*., 2002). The decrease in noise value occurs because it has been repaired by removing noise from the original image (denoising). In addition, on the canny operator edge detection appears the non-maximum suppression process, namely the process of reducing the average pixel value of an image that is not considered as an edge or a pixel located in the middle of the image, will be reduced by noise reduction. These two things cause the noise value to experience a decrease in the resulting image so that the image quality will increase (Khan *et al*., 2018).

On SNR values Based on the test results, it was shown that the SNR values generated on thorax CT scan images of COVID-19 patients after the application of the canny operator edge detection technique experienced an increase in SNR (Table 2). SNR is the ratio between the object signal's amplitude and the noise's amplitude. This SNR is related to the amount of X-ray energy used per pixel in the image (Bushberg *et al*., 2002). If the noise value decreases, the SNR divider factor will be small so that the SNR value will increase (Bushberg *et al*., 2002). An increase in SNR values occurs due to the impact of the repair by removing noise in the original image (denoising). Decreasing the value of this noise has a significant effect on SNR. If the value of the noise is experienced decrease, the dividing factor of the SNR will be small so that the SNR value will increase (Khan *et al*., 2018). In addition, on the canny operator, edge detection occurs. The process of non-maximum suppression reduces the value of image pixels that are not considered edges. This causes the noise value to experience a decrease in the resulting image so that the SNR value will increase (Khan *et al*., 2018). The results of this study are in accordance with previous research from Bhadauriah *et al*. (2013) and Sun *et al*. (2020), which states that the application of the edge detection method with the canny operator in improving image quality on thorax CT scan by reducing the noise value. Other studies have explained that edge detection used in thorax CT scan images with canny operators can increase the SNR in the heart arteries with CT Cardiac Angiography and improve the quality of organ images (Ramachandra *et al*., 2023; Noviana *et al*., 2017). Other research uses edge detection with the canny operator on a quantum-based thorax CT scan to produce gradient quantities by observing the strength of pixel values (Widiyanto *et al*., 2018).

In the anatomical information generated on thorax CT scan images of COVID-19 patients after the application of the canny operator edge detection technique, the sharpness and clarity of the image have increased (Table 3). This increase in anatomical appearance occurs due to improvements in the non-maximum suppression process, reducing the value of image pixels that are not considered edges. This is what causes the anatomical boundary information of the image after the application of the canny operator edge detection technique to become firmer and clearer based on the observations of radiologists.

The results of this study are in accordance with previous research, which states that a good thorax CT scan image display can increase anatomical information from images and improve disease diagnosis, especially in COVID-19 patients (Wu *et al*., 2020). Other studies explain that thorax CT Scan examinations make an essential contribution to diagnosis and determine the course of disease in COVID-19 patients, especially images that have good image quality will significantly determine the right and fast action for patients (Gunduz *et al*., 2020).

CONCLUSION

Based on the results of the research that has been done, it can be concluded that the use of canny operator edge detection techniques in the CT scan thorax image of the COVID-19 case was able to reduce noise. The tendency for noise reduction was 1.226, increasing the average SNR, the tendency for an increase in SNR was 0.136. The data processing results show a significant difference between the anatomical information on the CT scan thorax image of the COVID-19 case before and after using the canny operator edge detection technique.

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