Jurnal Ilmu dan Teknologi Kesehatan, Vol. 16 No. 1 Januari 2025 Hal 61-68
ISSN 2086-8510 (Print), ISSN 2655-5875 (Online)
https://doi.org/10.33666/jitk.v15i1.671 https://journal.uwhs.ac.id/index.php/jitk/article/view/671

THE EFFECT OF SLICE THICKNESS VARIATION ON SIGNAL TO NOISE RATIO (SNR) IN CT-SCAN THORAX EXAMINATION WITH CLINICAL TUMORS IN THE RADIOLOGY INSTALLATION

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Submitted: Dec 5th 2024 Revised: Dec 23rd 2024 Accepted: Jan 21st 2025 Published Online: Jan 24th 2025

ABSTRACT

Slice thickness is the thickness of the slice on the image that is determined during reconstruction using Multiplanar Reconstruction (MPR). Choosing the right slice thickness according to the purpose of the examination will produce accurate diagnostic information. One of the parameters that determines the quality of the results of an image is the Signal to Noise Ratio (SNR). Signal to Noise Ratio (SNR) is the comparison between the amplitude of a signal and the amplitude of noise. Tumors are one type of pathology in the thorax caused by cells that divide and grow uncontrollably. The purpose of this study was to determine the effect of slice thickness variations on the Signal to Noise Ratio (SNR) on CT-Scan thorax at the Radiology Installation of Andalas University Hospital Padang and the highest SNR value. This study is a type of quantitative research with experimental methods, data analysis and testing. The slice thickness variations used in this study were 2 mm, 3 mm and 4 mm. The sample of this study was 3 patients. Each sample was performed ROI on tumor tissue, tumor border, healthy tissue and background. This study was conducted at the Radiology Installation of Andalas University Hospital, Padang from April to June 2024. The results showed that in this study (ρ Value <0.05) which means Ho is rejected and Ha is accepted, there is a significant effect because there is an effect of slice thickness variations on SNR. And the highest SNR value is shown in sample 3 slice thickness 4 which produces an SNR value of 24.929.

Keywords : CT-Scan thorax; Slice thickness; Signal to Noise Ratio (SNR); Tumor

BACKGROUND

Computed Tomography (CT) Scan is one of the tools used to diagnose diseases in the human body using X-rays, without having to perform surgery so that more optimal diagnostic results are obtained (Siregar, 2020). One of the parameters that determines the quality of an image is the Signal to Noise Ratio (SNR). Signal to Noise Ratio (SNR) is the comparison between the signal amplitude and the noise amplitude. SNR is one of the parameters in assessing image quality in terms of noise. Noise has a close relationship with slice thickness, namely the greater the slice thickness, the noise value decreases with increasing tube voltage and slice thickness, the higher the transmitted photon energy from the X-ray tube, so that the number of photons to be measured or received by the X-ray detector increases and causes noise to decrease so that it gets good image quality. Noise is calculated as the standard deviation of the CT number in the ROI (Kartawiguna, 2015). In CT-Scan examination, there are parameters that must be considered by the radiographer. Some parameters that affect CT-Scan examination are kV, mA, FOV, slice collimation and slice thickness. Slice thickness is the thickness of the slice on the image that is set during reconstruction using Multiplanar Reconstruction (MPR) (Seeram, 2001). Choosing the right slice thickness according to the purpose of the examination will produce accurate diagnostic information. Choosing a thick slice thickness forms a low-resolution image, while a thin slice thickness forms a high-resolution image. The thinner the slice thickness, the greater the noise. Suboptimal CT-Scan imaging results can affect the doctor's diagnosis in diagnosing the disease, so image optimization is needed to produce an optimal image. Optimal image parameters are indicated by a high Signal to Noise Ratio (SNR) value.

According to Putri, et al., (2023) conducted a study on "The Effect of Slice Thickness Variation on The Anatomical Information of CT-Scan Paranasal Sinus Coronal Section in Clinical Rhinosinusitis" using slice thicknesses of 0.6 mm, 1 mm, 1.5 mm, and 2 mm, from this study it was found that where a thinner slice thickness produces better quality and will increase spatial resolution and increase the ability to distinguish small objects that have different densities on the same background. According to Hutami et al., (2021) conducted a study on the Effect of Slice Thickness Variations on CT-Scan Image Quality on air phantoms using slice thickness variations of 1 mm, 2 mm, 3 mm, 4 mm, 6 mm and 8 mm, from this study it was found that the thicker the slice thickness, the greater the CNR value. The level of CT-Scan image quality is not only influenced by the CNR value but also by the SNR value. According to Kusumaningsih et al., (2023) conducted a study on the Effect of Slice Thickness on the Signal to Noise Ratio (SNR) from Irradiation Results, this study found that slice thickness variations affect the SNR value, where the greater the slice thickness, the SNR

value increases and the image quality is better. According to Bisra (2020) conducted a study on the Difference in the quality of axial section MSCT thorax anatomical images in slice thickness reconstruction variations with clinical tumors, from this study it was found that a slice thickness of 2 mm with a mean rank value of 2.57 was better at displaying anatomical images than slice thicknesses 3 and 4.

Based on the author's observations at Andalas University Hospital Padang on Thorax CT-Scan examination with clinical tumors using a slice thickness of 3 mm. then the author is interested in knowing the effect of slice thickness variations on SNR on thorax CT-Scan with clinical tumors. based on previous theories and research, the author will use slice thickness variations of 2 mm, 3 mm, 4 mm and raise the title "The Effect of Slice Thickness Variations on Signal to Noise Ratio (SNR) on Thorax CT-Scan with Clinical Tumors at the Radiology Installation of Andalas University Hospital Padang". Research Objectives To determine the effect of slice thickness variations on the Signal to Noise Ratio (SNR) on thorax CT-Scan examination with clinical tumors at the Andalas University Installation Padang and to determine the variation in slice thickness that can produce images with high SNR values.

METHOD

The type of experimental approach research was conducted at the Radiology Unit of Andalas University Hospital, Padang in April-June 2024. The sample used in this study were patients with CT-Scan thorax examinations with clinical tumors at the Radiology Installation of Andalas University Hospital, Padang, as many as 3 patients. . The data that has been obtained is then ROI is carried out on the predetermined image results, namely the tumor part, tumor boundaries, healthy and background. Data processing uses statical product service solution (SPSS) with a simple linear regression test.

RESULT AND DISCUSSION

RESULT

A study has been conducted discussing the effect of slice thickness variation on the Signal to Noise Ratio (SNR) in thorax CT-Scan examinations. This study was conducted by reconstructing thorax CT-Scan examinations using subjects in the form of thorax CT-Scan patient data with clinical axial slices of lung tumors performed at the Radiology Installation of Andalas University Hospital, Padang.

ROI (Region Of Interest) Placement

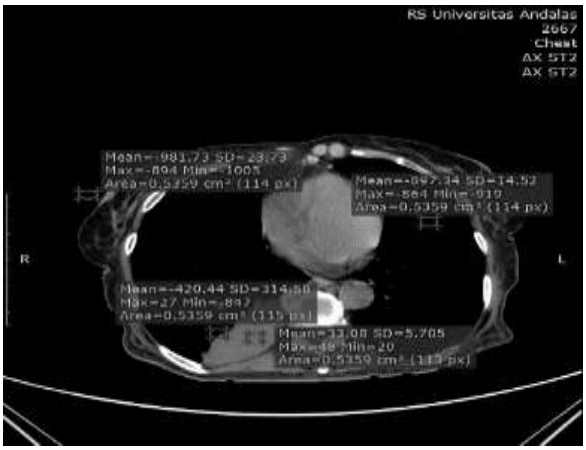
The following is the ROI placement performed on each sample:

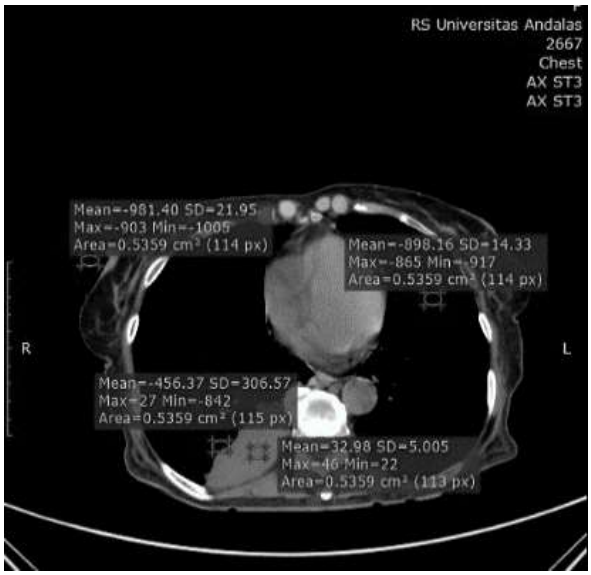
A. Sample 1

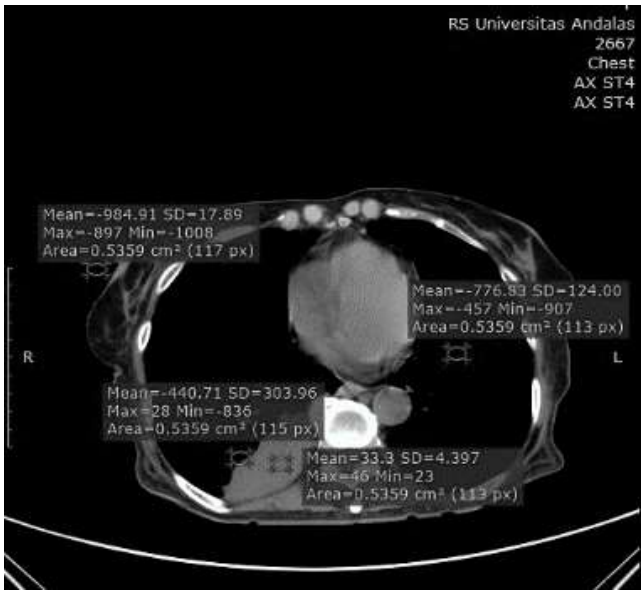

RS Universitas Andalas
1106
CT THORAX IV
AX ST 3
AX ST 3


RS Universitas Andalas
1106
CT THORAX IV
AX ST 4
AX ST 4

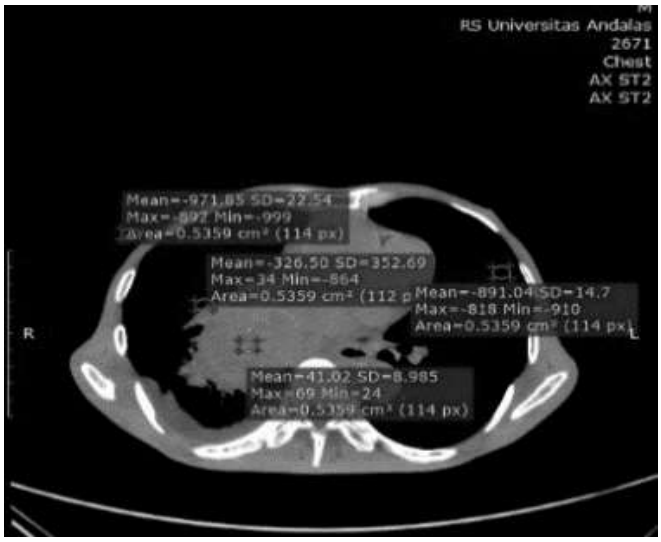
B. Sample 2


RS Universitas Andalas
2667
Chest
AX ST2
AX ST2


RS Universitas Andalas
2667
Chest
AX ST3
AX ST3
Mean=-981.40 SD=21.95
Max=-903 Min=-1005
Area=0.5359 cm² (114 px)
Mean=-898.16 SD=14.33
Max=-865 Min=-917
Area=0.5359 cm² (114 px)
R
L
Mean=-456.37 SD=306.57
Max=27 Min=-842
Area=0.5359 cm² (115 px)
Mean=32.98 SD=5.005
Max=46 Min=22
Area=0.5359 cm² (113 px)


RS Universitas Andalas
2667
Chest
AX ST4
AX ST4
Mean=-984.91 SD=17.89
Max=-897 Min=-1008
Area=0.5359 cm² (117 px)
Mean=-776.83 SD=124.00
Max=-457 Min=-907
Area=0.5359 cm² (113 px)
R
L
Mean=-440.71 SD=303.96
Max=28 Min=-836
Area=0.5359 cm² (115 px)
Mean=33.3 SD=4.397
Max=46 Min=23
Area=0.5359 cm² (113 px)

C. Sample 3


RS Universitas Andalas
2671
Chest
AX ST2
AX ST2
Mean=-971.85 SD=22.54
Max=-897 Min=-999
Area=0.5359 cm² (114 px)
Mean=-326.50 SD=352.69
Max=34 Min=-864
Area=0.5359 cm² (112 p
Mean=-891.04 SD=14.7
Max=-818 Min=-910
Area=0.5359 cm² (114 px)
R
L
Mean=41.02 SD=8.985
Max=69 Min=24
Area=0.5359 cm² (114 px)

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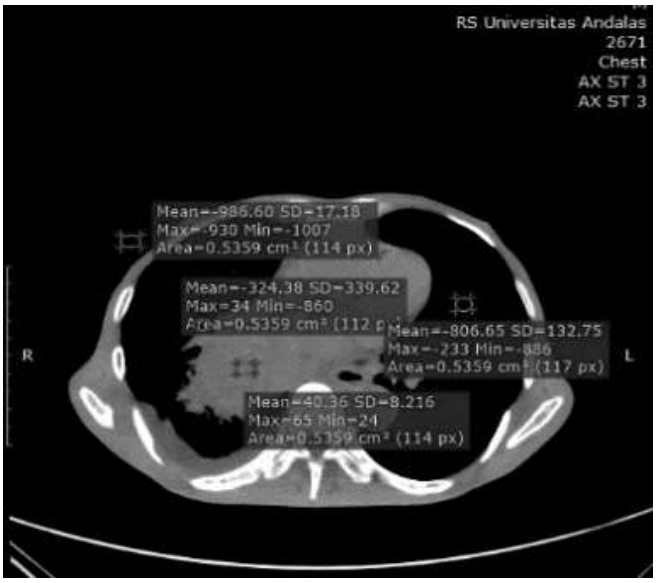

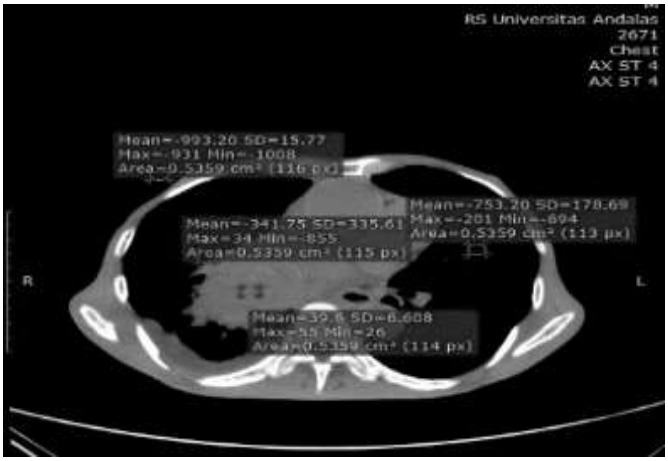

After obtaining the CT-Scan thorax image from each sample, the next step is to reconstruct the thickness of the thorax image slices into 2, 3, and 4 mm. After that, ROI is performed on each sample. ROI is performed at 4 points on the image, namely in the tumor area, healthy area, tumor boundary area, and in the background area. The ROI results from each sample are later entered into the formula to obtain the SNR value. The ROI results for each sample obtained can be seen in Table 1.

Table 1. Placement of ROI for slice thickness variations

	ROI				
	Slice thickness	Tumor	Tumor Border	healthy area	SD Background
Sampel 1	2	23,78	-334,76	-882,26	21,25
	3	22,25	-325,86	-880,99	18,64
	4	22,33	-319,63	-778,51	16,07
Sampel 2	2	33,08	-420,44	-897,34	23,73
	3	32,98	-456,37	-898,16	21,95
	4	33,3	-440,71	-776,83	17,89
Sampel 3	2	41,02	-326,5	-891,04	22,54
	3	40,36	-324,38	-806,65	17,18
	4	39,6	-341,75	-753,2	15,77

Table 1 shows the results of the ROI values for each slice thickness variation. Furthermore, from the ROI values in Table 1, the SNR value is calculated. The SNR value is obtained from the ROI process data, then the signal in each

tissue is determined by taking the mean value for each image (tissue), and the noise value is taken from the standard deviation value listed on each image (background). The Signal to Noise Ratio (SNR) value uses the equation:

$$SNR = \frac{\mu}{\sigma}$$

μ = mean object value (HU)

σ = standard deviation value of the background (HU)

The average value of the mean object in the tissue is divided by the standard deviation value of the background. After calculating using the equation above, the SNR value was obtained for the CT-Scan examination of the thorax with clinical tumors with each sample can be seen in table 2.

Table 2. Average mean value of objects and standard deviation of background for slice thickness variation.

Sampel	*Slice thickness*	SNR
1	2 mm	19,463
	3 mm	21,979
	4 mm	23,241
2	2 mm	18,975
	3 mm	21,070
	4 mm	23,306
3	2 mm	18,612
	3 mm	22,727
	4 mm	24,929

From table 2 it is found that the SNR value varies with slice thickness, the table shows that the thicker the slice thickness variation, the SNR value increases. From the results of the SNR value calculation, one data was obtained that showed the highest SNR value of the three samples, namely data from sample 3 slice thickness 4 with a value of 24.929.

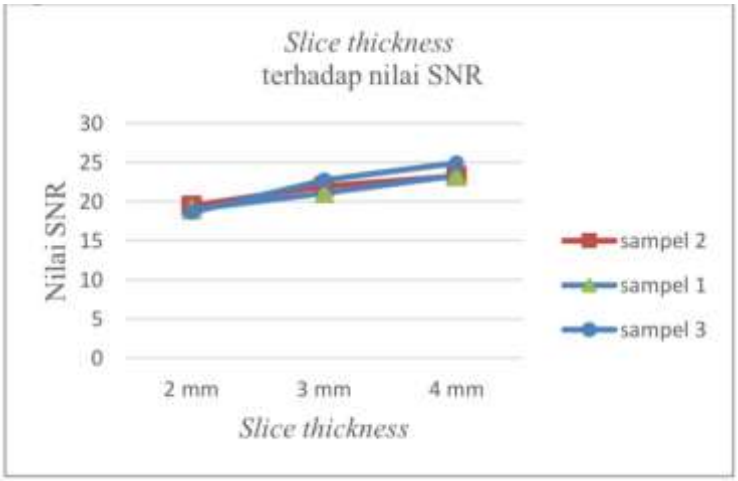

Figure 1. Graph of the relationship between slice thickness and SNR value.

Based on the graph in Figure 1, it shows that the thicker the slice thickness, the more the SNR value increases for each sample.

DISCUSSION

1. Effect of slice thickness variation on SNR

Based on the data normality test of each variable using the Shapiro-Wilk method, it is known that the distribution of the variable data is normal because it has a p value of more than 0.05. The coefficient of determination R square = 0.895 with a significant level of p of 0.000 <0.05, then Ho is rejected and Ha is accepted, it can be concluded that there is an effect of variations in slice thickness on SNR. The large value of the correlation/relationship (R) is 0.946 from the output, the coefficient of determination (R square) is 0.895. These results indicate that variations in slice thickness have an effect of 89.5% on the SNR value, meaning that slice thickness has a significant effect on the SNR value obtained, thus affecting the quality of the resulting image as well. Based on the data normality test of each variable using the Shapiro-Wilk method, it is known that the distribution of the variable data is normal because it has a p value of more than 0.05. The coefficient of determination R square = 0.895 with a significant level of p of 0.000 <0.05, then

Ho is rejected and Ha is accepted, it can be concluded that there is an effect of variation in slice thickness on SNR. The large value of the correlation/relationship (R) of 0.946 from the output, the coefficient of determination (R square) is 0.895. These results indicate that the variation in slice thickness has an effect of 89.5% on the SNR value, meaning that the slice thickness has a significant effect on the SNR value obtained, thus affecting the quality of the resulting image as well. The selection of the right slice thickness according to the purpose of the examination will produce accurate diagnostic information. The selection of thick slice thickness forms a low-resolution image, whereas thin slice thickness forms a high-resolution image. The thinner the slice thickness, the greater the noise. Suboptimal CT-Scan imaging results can affect the doctor's diagnosis in diagnosing the disease, so image optimization is needed to produce optimal images. Image parameters are said to be optimal, indicated by a high Signal to Noise Ratio (SNR) value. Noise has a close relationship with slice thickness, namely the greater the slice thickness, the noise value decreases with increasing tube voltage and slice thickness, the higher the transmitted photon energy from the X-ray tube, so that the number of photons to be measured or received by the X-ray detector increases and causes noise to decrease so that it gets good image quality. The use of thin slice thickness will produce a minimum SNR value, this is due to the large amount of noise in the image which makes the image quality low, while the use of thick slice thickness produces a maximum SNR value because it is caused by the small amount of noise in the image which makes the image quality better. This is in accordance with the research of Kusumaningsih et al., (2023) that variations in slice thickness affect the SNR value, where the greater the slice thickness, the SNR value increases and the image quality improves. This is in accordance with the research of Kusumaningsih et al., (2023) that variations in slice thickness affect the SNR value, where the greater the slice thickness, the SNR value increases and the image quality improves.

2. What slice thickness variation can produce an image with a high SNR value

The SNR values in the three patients have different values at each Slice thickness variation value. This happens because the patients have tumors that are in different locations, causing the signal intensity of each tissue to be different. Judging from the magnitude of the attenuation of each tissue, it is said to be good in determining image quality if the tissue examined according to the case produces a high SNR value so that it produces an optimal image. The image parameters are said to be optimal, indicated by a high Signal to Noise Ratio (SNR) value. The SNR results obtained by the author are in sample 1 slice thickness 2 produces an SNR value of 19.463, slice thickness 3 produces an SNR value of 21.979, slice thickness 4 produces an SNR value of 23.241, sample 2 slice thickness 2 produces an SNR value of 18.975, slice thickness 3 produces an SNR value of 21.070, slice thickness 4 produces an SNR value of 23.306, and sample 3 slice thickness 2 produces an SNR value of 18.612, slice thickness 3 produces an SNR value of 22.727, slice thickness 4 produces an SNR value of 24.929. From the SNR results obtained, the greater the slice thickness, the higher the SNR value. It can be concluded that the highest SNR value is in slice thickness 4 in sample 3 producing an SNR value of 24.929 and each sample that produces the highest SNR value is in slice thickness 4.

CONCLUSION AND SUGGESTION

Based on the research that has been done, it can be concluded that the variation of slice thickness has an effect of 89.5%. on the results of CT-Scan examination of the thorax with clinical tumors, where the greater the slice thickness, the SNR value increases and the image quality is better. The highest slice thickness variation in CT-Scan examination of the thorax with clinical tumors is shown in slice thickness 4 of each sample. Sample 1 slice thickness 4 produces an SNR value of 23.241, sample 2 slice thickness 4 produces an SNR value of 23.306 and sample 3 slice thickness 4 produces an SNR value of 24.929. Of the three samples, sample 3 with a slice thickness variation of 4 produces the highest SNR value.

Based on this research, the researcher suggests performing image reconstruction with slice thickness variations plus variations in other parameters with consideration to reduce noise and artifact values in the image in order to produce a more optimal image for the purposes of a doctor's diagnosis.

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