Analysis of image information of diffusion weighted image (DWI) MRI on stroke ischemic using unsharp mask technique

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Abstract. Magnetic Resonance Imaging (MRI) is one of the modalities that can be used to diagnose stroke ischemic using the Diffusion Weighted Image (DWI) sequence. However, DWI sequence has a weakness. It is the presence of low signal levels which will result an image blurring. One way to reduce the blurring is by adding Propeller technique. Yet, the disadvantage of using this technique is that it takes longer time to do it. The unsharp mask technique is a post processing technique that is used to improve an edge information on the image and reduce blurring from the image. The purpose of this study is to determine the difference in image information after the unsharp mask technique is performed on the Ischemic Brain Stroke MRI Examination on DWI Sequences. This research is a quasi experimental with a Pre Post Test Only Group Design. The resulting image is given unsharp mask techniques with matrix variations 3x3, 5x5, and 7x7. The Friedman statistical test results for image information obtained p-value <0.05 which means that there is a difference in image information between before and after unsharp mask technique with increase the detail and edge on digital image and produces image information optimally by giving a 3x3 matrix.

1. Introduction

Stroke is a disease in the brain in the form of impaired local and global nerve function, the emergence of sudden, progressive, and rapid. Impaired nerve function in the stroke is caused by non-traumatic cerebral circulatory disorder. The nerve disorder causes symptoms such as: facial paralysis or limbs, influent speech, unclear speech (dysarthria), possible changes in consciousness, visual impairment, etc. The number of stroke sufferers in Indonesia in 2013 based on the diagnosis of health workers (paramedics) was estimated 1,236,825 people (7.0%), while based on the diagnosis of pramedics / symptoms estimated 137,941 people (12.1%) [1].

Stroke is divided into two types, namely ischemic stroke and hemorrhagic stroke. Ischemic stroke is a stroke that occurs because the blood flowing to the brain stops due to atherosclerosis (the buildup of cholesterol in the walls of blood vessels) or blood clot that has clog a blood vessel to the brain, while hemorrhagic stroke occurs because there is direct bleeding to the brain caused by leakage of blood from the intra cerebral arterioles damaged by the high blood [2].

Magnetic Resonance Imaging (MRI) is one of the modalities that can be used to diagnose cases of stroke that work using magnetic fields and radiofrequency to visualize body tissues, blood flow, and metabolic functions of the body. One type of MRI examination is the brain examination [3]. The Brain MRI Examination Protocol is T2 Axial Fast Spin Echo (FSE), T1 Axial Spin Echo (SE), Axial Fluid Attenuated Inversion Recovery (FLAIR), T2 Sagittal / Coronal FSE, and additional Diffusion Weighted Image (DWI) sequences [4].
Diffusion Weighted Image (DWI) has a high sensitivity in diagnosing acute infraction in the brain. DWI utilizes a molecular motion used to describe movements in extra cellular space due to the random thermal movements called diffusions. This movement is limited by boundaries such as ligaments, membranes and macromolecules. DWI is used to assess the diffusions in the brain tissues and is well used to degrade the presence of early strokes [5], but the resulting image on the DWI sequence has a shortage of low signal level resulting in a blur image [6]. This size image is due to the loss of signal intensity at the outer edges in K-space, because the outer edges of the K-space relates to the details so that on the DWI sequence will produce a blurred image. Blurred image can reduce image quality that can cause difficulty in interpretation because the information conveyed by the image reduces [7]. In clinical practice propeller became the routine sequence to reduce image bluring [8].

DWI employing a propeller sequence constitutes a difference approach to turbo spin echo (TSE) sequence, which uses a series of pulse refocusing to create a series of Spin Echo. This method can reduce artifacts by acquiring each line in the K-space at the center spin Echo, thereby avoiding the accumulation errors that cause blurring on the DWI sequence, but the disadvantage of using this technique is it takes longer time 3 minutes [9,10]. One of the ways to overcome the shortage of propeller is by giving the unsharp mask technique.

The unsharp mask technique is a post processing technique which is used to remove unhomogeneity in the MRI image by enhancing the edge information on the imagery. The unsharp mask is one of the prominent image enhancement techniques could be applied in every field including MRI [11]. The unsharp mask is made with Matlab software, operates by parsing the size of the original image on the edges of the image. Using that technique the lack of homogeneity in image because of the movement of patient can be reduced. Besides that, the advantage of unsharp mask is time efficiency. [12]

So far, the unsharp mask technique has not been used in DWI sequence, therefore the authors hope it can help doctors in assessing the criteria of the characteristic [13], as the result the patient is not carried back to the examination. Moreover, it can be improve the safety of patient and efficiency for the stroke treatment [15]. The purpose of this study is to determine the difference in image information after the unsharp mask technique is performed on the Ischemic Brain Stroke MRI Examination on DWI Sequences.

2. Methods
The type of research used is quasi for with PrePost Test only Group Design. Prepostest only group design is a research design that contains pretest before being given treatment and posttest after being given treatment. Thus it can be known to be more accurate because it can compare between before and after being treated [16], by using this design, the researchers wanted to know that the use of unsharp masks on MRI images of ischemic brain strokes can increase image information.

The study uses ischemic Stroke patients to obtain the desired MRI image. Research was conducted at the radiology Unit with 15 patient ischemic brain stroke consisting of 9 males and 6 females patients.

Research was conducted on the Diffusion Weighted Image (DWI) sequence on ischemic stroke pathology by using a 1.5 Tesla Siemen MRI with the type Magnetum Avanto. Patients with ischemic stroke pathology were subjected to MRI examination by giving DWI sequences. The results of the DWI image are then performed to improve the image to reduce bruring by providing the unsharp mask technique with $3\times3$, $5\times5$ and $7\times7$ matrix variations performed on MATLAB software. After obtaining the image from the unsharp mask filter application, a qualitative assessment is carried out by 2 radiology doctors by filling out a questionnaire sheet and giving scores that is score 1 with the meaning of "less clear" (objects that are judged to have boundaries that are not clear, blurry, and difficult to observe), score 2 with the meaning "quite clear" (the object being assessed can be seen although it must be done more carefully) and score 3 with the meaning of "clear" (the edge between the objects that are considered to have clear boundaries, and are easy to observe) in organ white matter, gray matter and infarction. If the doctor's assessment has been collected, then the statistical test will be continued using SPSS 22 to perform the kappa test and the Friedman test. Kohen's Kappa test was conducted to see the level of agreement between the two doctors. After obtaining the kappa to see the level of agreement,
one of the respondents who had experience reading MRI images of ischemic strokes was taken to continue with the Friedman statistical test which aims to determine differences in matrix variations on image information. Friedman test was performed because the data were nonparametric with ordinal data.

3. Results and discussion
First, this research was conducted by inserting the MRI image of the brain of the ischemic stroke into the MATLAB software with the DCOM format, the result shown in the figure 1.

![Figure 1](image)

Figure 1. Represent image of 1 patient of the ischemic stroke in whole brain from 15 total patients (a) Original Image, (b) Unsharp Mask 3x3, (c) Unsharp Mask 5x5, (d) Unsharp Mask 7x7

The results of the image after being entered into the MATLAB program by giving the unsharp mask technique were assessed by 2 radiologist to fill out the questionnaire sheet. The results of the questionnaire of the two radiologist were then taken by one of the respondents who had experience reading MRI images of ischemic stroke for more than 5 years. The results of the questionnaire assessment were carried out on 3 organs namely white matter, gray matter and infarction, on 15 patients. The data from that questionnaire assessment that consist of original image and 3 variations of the matrix unsharp mask (matrix 3x3, 5x5, and 7x7) to be followed by statistical analysis using friedman test [17]

The Friedman test aims to determine the differences in matrix variations on the MRI image information of Brain ischemic stroke with DWI sequence by looking at the mean rank value. The mean rank value is used when the p value for each matrix variation is <0.05, which indicates that there is a difference in each matrix variation, then the mean rank is used to see which group has the highest average compared to other groups. The Friedman test results for whole organs shown in table 1

From Friedman's test results to the whole organ in all groups data has a p value < 0.05 which means there is a difference between each variation for the entire organ. Based on the result on table 2 of the mean rank for the highest value is in the matrix 3x3 with mean rank 3.43 in the the lowest is matrix 7x7 with the mean rank 1.50

| No | Matrix                          | p-value   |
|----|---------------------------------|-----------|
| 1  | Original Image - Unsharp mask 3x3 | 0.000063  |
| 2  | Original Image - Unsharp mask 5x5 | 0.028     |
| 3  | Original Image - Unsharp mask 7x7 | 0.00005   |

Table 2. Mean Rank for whole organs

| No | Matrix | Mean Rank |
|----|--------|-----------|
| 1  | Original Image | 2.73 |
| 2  | Unsharp mask 3x3 | 3.43 |
| 3  | Unsharp mask 5x5 | 2.73 |
| 4  | Unsharp mask 7x7 | 1.50 |

Table 1. Friedman test results for whole organs variations of each

While the Friedman test for each organ is obtained from testing one by one from each organ with 15 patient data, 3 matrix variations, original image, the result shown in table 3. From the results of the
Friedman test for each organ, white matter has a significance value of 0.00043, gray matter has a significance value of 0.00003 and infraction has a significance value of 0.003. From all organs it can be seen that the p value is <0.05, which means that there are differences between the variations for each organ.

| No | Organs   | Matrix variation | Mean | p-value |
|----|----------|------------------|------|---------|
| 1  | White Matter | Original Image  | 2.40 | 0.00043 |
|    |          | Image 3x3        | 3.23 |         |
|    |          | Image 5x5        | 2.80 |         |
|    |          | Image 7x7        | 1.57 |         |
| 2  | Gray Matter | Original Image  | 2.10 | 0.00003 |
|    |          | Image 3x3        | 3.37 |         |
|    |          | Image 5x5        | 3.00 |         |
|    |          | Image 7x7        | 1.53 |         |
| 3  | Infarction | Original Image  | 2.60 | 0.003   |
|    |          | Image 3x3        | 3.13 |         |
|    |          | Image 5x5        | 2.63 |         |
|    |          | Image 7x7        | 1.63 |         |

Figure 2. Image results for each organ
(a) Before unsharp mask, (b) After unsharp mask with matrix 3x3, (c) After unsharp mask matrix 5x5, (d) After unsharp mask matrix 7x7

Figure 2. Shows the results of the image before and after being given the unsharp mask technique where, 1 is white matter, 2 is gray matter and 3 is infraction. The image after being given the unsharp technique has sharper organ boundaries, but it should be noted that if the matrix is too high it will cause an increase in noise and the image is increasingly blurry, this is in accordance with The Friedman test which has been carried out where the maximum result is an image of the unsharp mask technique with a 3x3 matrix variation.

Unsharp mask is a method that enhances the sharpness of the line (edge) and other high-frequency image elements through a procedure that reduces the original image (substract) by a version that is less sharp or more mashed to obtain sharp image results [18]. The advantage of using an unsharp mask is to increase the detail and edge on digital imagery. With the sharpening on the edges of the image will automatically affect the resulting image information. Based on friedman test results, obtained the highest mean rank on the image with matrix 3 x 3 and the lowest mean rank obtained on the image matrix 7 x 7, it is because with the increase of the value of the matrix, then there will increase noise and the image result will increasingly blur [19].
4. Conclusions
The conclusion is the application of unsharp mask causes a difference in image information with a variation of matrix 3x3, 5x5, and 7x7. Optimal image information for MRI brain stroke with unsharp mask technique is a 3x3 matrix variation.

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