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Analysis of the Quality of Natural Dyes in Weaving Exposed to Sunlight Using MSE and PSNR Parameters

Patrisius Batarius[1], Alfry Aristo Sinlae[2], Elisabeth F. Fahik[3]
[1,2,3]Computer Science, Faculty of Engineering, Widya Mandira Catholic University
[1]patrisbatarius@unwira..ac.id, [2]alfry.aj@unwira.ac.id, [3]elisabetferonikafahik@gmail.com

Abstract

It is widely assumed that natural dyes in weaving degrade in quality when exposed to sunlight for an extended period of time. This indication is clearly visible to the naked eye. There is currently no standard for evaluating the quality of natural dyes. The Boti tribe's weaving on Timor Island, East Nusa Tenggara Province, is one type of weaving that uses natural dyes. The dye is made from corn flour and a combination of "nobah" leaves and the bark of the "bauk ulu" tree (from the local language). White (from corn flour) and blue-black are the colors produced by dyeing the yarn. The purpose of this research is to examine the image quality of the Boti tribe's woven fabric. The parameters used were Means Square Error (MSE), Peak Signal to Noise (PSNR), and RGB values. The image of the weaving used as a reference is compared to the image of the sun-dried weaving. The image capture distance was 30 cm, and the cropped RGB image size was 423x623x3. The experimental method was used in the research. The drying time was one hour, and it was repeated every one hour between 10:00 and 15:00 local time. The sun-dried images were photographed, and parameter comparisons were performed for analysis. The results demonstrated that the MSE and PSNR methods were effective in measuring the image quality of weaving dyed with natural dyes. The average value has changed by 8.42% for the R value, 8.58% for the G value, and 9.68% for the B value. The average PSNR for RGB images is 9.44288 dB, and the MSE is 7477.52. For grayscale images, the average PSNR is 10.52 dB and the average MSE is 5832.06.

Keywords: Natural Dyes; MSE; PSNR, RGB;

1. Introduction

Natural dyes are commonly used in East Nusa Tenggara Province weaving. The use of natural dyes is passed down from generation to generation of weavers. Natural dyes have a lower development quality than industrial dyes. Color changes are seen in weaving that has been exposed to industrial detergents or direct sunlight for an extended period of time. The Boti tribe is the oldest tribe on the island of Timor in East Nusa Tenggara, using natural dyes in the weaving dyeing process [1]. Blue-black is one of the colors created. This color is created by dipping yarn in a mixture of "taum" and "ao" ("taum" and "ao" are words from the local language). The dyeing of yarn takes two hours. There is also a white color component derived from corn flour. The corn is ground, and the flour is boiled until thick, then placed in the pan, and the thread is dipped in the pan. The immersion time is approximately 1-2 hours. While the brown color is obtained by dipping cotton thread in a mixture of nobah leaves and bark from the bauk ulu tree (from the local language).

Natural dyes are typically derived from plants. Several local plant species based on tree families that produce different types of colors have been identified [2]. The plants are found in the surrounding area, where weaving is produced [3][4]. Silk dyeing also creates a color that is described in the form of a code [5].

The use of mordant in various methods results in more vibrant colors [6]. The color produced by the ethanol solvent process is also affected by time [7].

Batik cloth, in addition to weaving, employs natural dyes. Several factors can influence the quality of natural dyes used in batik cloth. The length of the soaking process influences the quality of the natural color in batik that uses natural dyes. The natural materials used, as well as the length of time the cloth soaks in the natural materials used, influence the quality of batik dyes [8]. Batik quality is also affected by differences in fixation [9].

Digital image processing is the use of specific techniques to transform one image into another. Image processing is designed to improve the quality of image

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display, reduce image file size while still maintaining the image, and restore or repair the image to its original condition. One of them is an image enhancement technique for historical documents that uses contrasting adaptive histogram alignment to keep the original image displayed even though the document is old [10].

Color image quality is measured using several parameters, including numerical evaluation using computational time, PSNR, MSE performance criteria, and SSIM. Although the color difference values of the two methods differ significantly, each method performs well when measuring color differences. However, it should be noted that the RGB space model is dependent on the input, so the closer the value is to the color difference of the laboratory measurement value, the more accurate the digital image with the original sample. A spectrophotometer is used in the color measurement method, and mathematical calculations from digital images can be used [11].

The color intensity test results revealed that 50% pineapple leaf fiber: 50% cotton was able to bind L* (brightness) stronger. This type of turmeric dye binds to the axis (color tendency) more strongly at a* (red color) and b* (yellow color) values than the avocado dye type. The treatment of the proportion of 100% cotton yarn with turmeric dye with a value of 0.198 produces the best results based on the intensity of the color chosen [12].

Image quality is frequently measured using parameters such as Means Square Error (MSE), Peak Signal Noise to Ratio (PSNR), and the shape of the image histogram. Peak Signal to Noise Ratio (PSNR) and Mean Square Error (MSE) Image Quality Improvement Algorithm (MSE) [13]. The PSNR parameter is used in research to estimate the level of distortion caused by JPEG compression of an image from any structural content [14]. Image compression scheme and method classification are used to reduce the blocking effect using Means Square Error (MSE) and Peak Signal to Noise Ratio (PSNR) [15].

In other image compression research, methods such as DWT and DCT are used. In terms of compression, it is claimed that the DWT algorithm outperforms the DCT algorithm. The Mean Square Error (MSE) and Peak Signal to Noise Ratio (PNSR) parameters are used to calculate this [16]. PSNR could also be optimized to sharpen images using eight filter directions defined by the two parameter values [17]. The Weighted Average Brovey Transform method is used to merge two images to create a new image, which increases PSNR while decreasing MSE [18]. The MSE and PSNR parameters are also considered when analyzing the performance of the JPEG Algorithm [19].

Weaving with natural dyes has a short lifespan. This is a common viewpoint for some woven fabrics in NTT Province that use natural dyes. One of them is a weaver in the Boti Tribe area. There are currently no standards in place to determine the quality of natural dyes that degrade when exposed to sunlight. The subjective assessment of the results by looking directly at the human naked eye is a benchmark that natural dyes on weaving have decreased color quality after being exposed to sunlight for an extended period of time. The purpose of this research is to determine the image quality on the Boti Tribe's weaving as a result of exposure to sunlight. The woven image is processed using image processing techniques. Perubahan kualitas citra pada kain tenun dianalisis. Changes in image quality on weavings were examined. The parameters used are Mean Square Error (MSE) and Peak Signal-to-Noise Ratio (PSNR). PSNR is calculated to compare two images, namely the original image and the image produced by direct drying in sunlight. The two parameters listed above are general parameters used to determine the quality of an image after it has been processed. This study, in addition to PSNR, shows a histogram of the RGB value comparison between the original image and the image exposed to direct sunlight. According to Cheddad's research, the PSNR value is 30 dB. If it is greater than this value, the image quality that changes is difficult to distinguish visually [20]. However, if it is less than 30 dB, the quality has significantly changed.

2. Research Method

This is an experimental study.

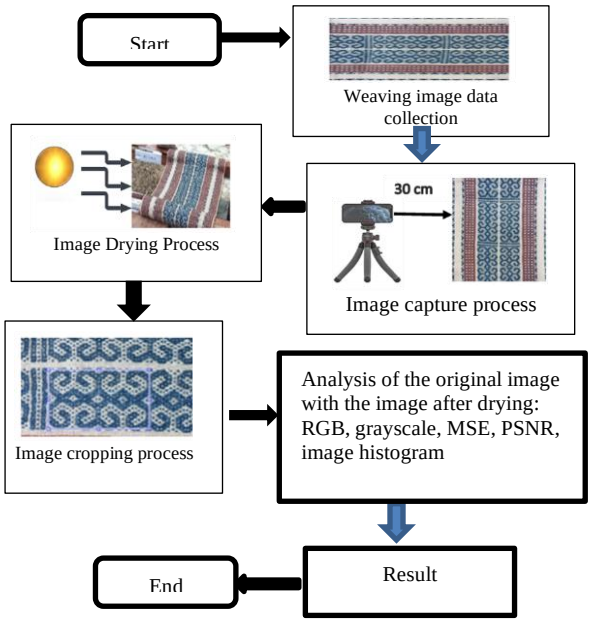

Figure 1. Research flowchart

The steps in the image above are described as follows:

1. Stage 1 Data collection

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Identify the colors produced by natural dyes on the threads used to make weavings at this stage. The materials and colors produced by conducting direct interviews with a group of weavers in the Boti tribe include:

a) The color white. The process of producing white color by pounding the corn and boiling the flour until it is thick, then pouring it into a skillet and dipping the thread into it. The immersion time is approximately 1-2 hours.
b) Brown. Cotton that has been spun into yarn is dipped in a mixture of nobah leaves and bauk ulu tree bark (from the local language).
c) Dark blue thread dipped in a mixture of "taum" and "ao" ("taum" and "ao" are local terms). The dyeing process takes two hours.
d) Red color achieved by combining whiting with "bauk ulu" and "nobah".
e) Tarum mixed with whiting to create a black color.

Figure 2 shows the type of weaving used in this study.

Figure 2. Boti Tribal Weaving Pieces

2. Stage 2 weaving drying
The drying process is repeated every 1 hour from 10:00 to 15:00 local time, where one cloth is divided into 5 parts and each part is dried for 1 hour at different times, for a total drying time of 5 hours. Figure 3 depicts the drying process of the research object, woven cloth.

Figure 3. Weaving drying process

3. Stage 3 image capturing
Weaving was photographed with a smartphone camera with the following specifications: Samsung SM-A315G F2.0 1/50s 4.60mm ISO 125 and a 9:16 aspect ratio. The distance of image retrieval is 30 cm and the process of taking photos is one day after drying. Figure 4 depicts the model for photographing weaving.

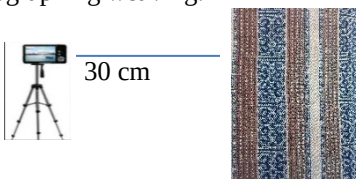

Figure 4. The process of capturing the cloth after it has dried

4. Stage 4 image cropping
The weaving color used for the research process is white and blue, and the image cutting procedure is carried out with the Matlab application. 423x623x3 is the image size that should be used. The image at issue is an RGB image. Figure 5 depicts the image cropping process in Matlab.

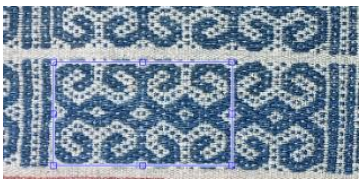

Figure 5. Cropping an Image to a Specific Size

5. Stage 5 image analysis result comparison.
MSE and PSNR are the parameters used in the analysis of the dried image. The image analysis steps are as follows:

a) The first examination is a grayscale image.
   1) The original image and the image that has dried in the photo, separated by 30 cm.
   2) The RGB image is converted to grayscale.
   3) A Gaussian filter is then applied to the grayscale image to restore it. The convolution operation on the image yields the Gaussian filter. The multiplication operation is performed between the kernel matrix and the original image matrix. The Gaussian filter kernel matrix used here is 3x3.
   4) Use a Gaussian filter to save the restored image.
   5) Determine the MSE and PSNR values for each image.
b) The second analysis is the grayscale image.
   The second analysis compares the MSE and PSNR values of the original image to those of the image after drying. The image used is a grayscale image that was created by using a Gaussian filter during the restoration process.
c) The third analysis is the calculation of the MSE and PSNR of RGB images
   This method does not include image restoration. The cropped image is directly calculated for the MSE and PSNR values between the original image and the dried image.
d) The 4th analysis displays an image histogram
   This study compares MSE and PSNR values for RGB and grayscale images, as well as image histograms for both reference and sun-dried images.

3. Result and Discussion

Only certain images were taken in this study, as shown in Figure 5. Table 1 depicts the appearance of the original image before drying and 5 other images after drying for a specified amount of time. Table 2 also includes the calculated values for each MSE and PSNR

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between the original image (before drying) and the dried image.

Table 1. Weaving Image Data Before and After Drying

 Original image	 Drying 10am-11am
 Drying 12pm-1pm	 Drying 11am-12pm
 Drying 1pm-2pm	 Drying 2pm-3pm

Table 2. MSE and PSNR values for grayscale images for each image

No	Drying hour	MSE		PSNR	
		Noise contaminat ion	Restoration	Noise contaminat ion	Restoration
1	Original	40,6435	47,1970	32,0749	31,4257
2	10:00 - 11:00	40,6047	47,1413	32,0790	31,4308
3	11:00 - 12:00	47,7376	53,2508	32,0648	30,9015
4	12:00 - 13.00	41,1125	47,1059	32,0251	31,4340
5	13:00 - 14:00	40,6534	52,6848	32,0738	30,9479
6	14:00 - 15:00	40,9605	47,0100	32,0411	31,4429

Table 2 shows that the contaminated image's MSE value is greater than 40 and the restored image's PSNR value is greater than 30 Db. The PSNR value is greater than 30 dB, indicating that the two images are very similar [20].

Changes in the quality of natural dyes in the image were calculated by comparing the MSE and PSNR values of the original image and the dried image. The sun-dried image is compared to the original image at a specific hour. Table 3 displays the results of the MSE and PSNR values.

Table 3. Grayscale image MSE and PSNR values in images between the original image and the dried image

No	Drying hour	MSE	PSNR
1	10:00 - 11:00	4.316,60	11,7794
2	11:00 - 12:00	5.988,30	10,3578
3	12:00 - 13:00	6.220,90	10,1923
4	13:00 - 14.00	6.391,00	10,0751
5	14:00 - 15:00	6.243,50	10,1765
Average		5.832,06	10,52

Table 3 shows that when comparing the original image to the dried image, the MSE and PSNR values show very significant differences in value where the PSNR value is less than 30 dB. This demonstrates how significant the difference between the original image and the image after drying is. Figures 7 and 8 depict graphs of MSE and PSNR values.

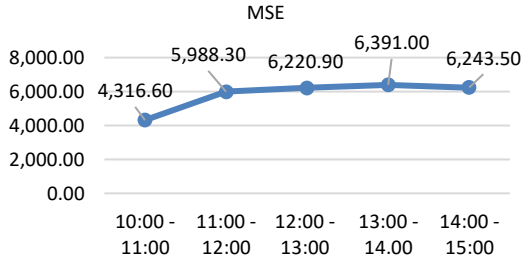

Figure 7. Grayscale images' MSE value versus drying time

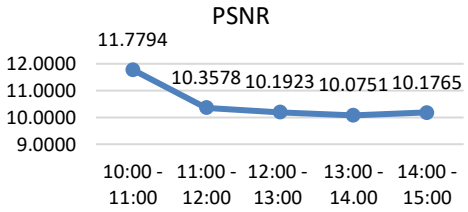

Figure 8. PSNR value versus drying time for grayscale images

MSE and PSNR values for RGB images are calculated by comparing the original image to the dried image. Table 4 shows that the PSNR value is less than 30 dB. The difference in the PSNR value of the input images between the first and second drying times is 1 dB. The drying time is one hour, with the lowest PSNR value at 13:00-14:00. This change in value demonstrates that the MSE and PSNR methods are more effective than direct objective assessments with the human eye in determining the image quality of cloths dyed with natural dyes.

Table 4. RMS and PSNR values for RGB images compared between the original image and the dried image

Hour	MSE	PSNR
10:00-11:00	5401,9	10,8053
11:00-12:00	7890,9	9,1595
12:00-13:00	7960,9	9,1212
13:00-14:00	8188	8,999
14:00-15:00	7945,9	9,1294
Average	7477,52	9,44288

Figures 9 and 10 show graphs of changes in MSE and PSNR values with drying time based on table 4 above.

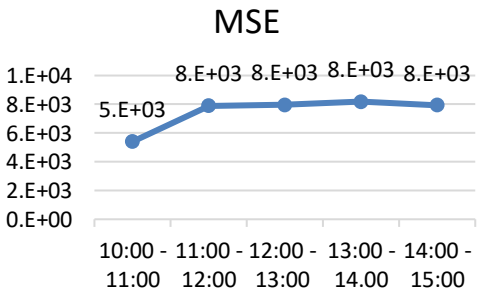

Figure 9. MSE versus drying time for RGB image

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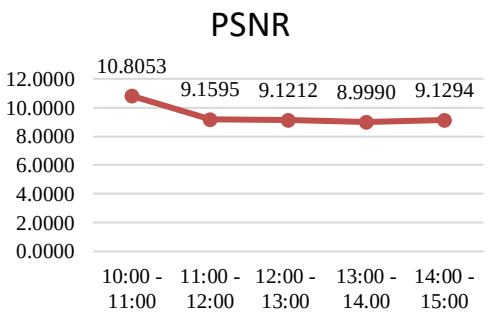

Figure 10. PSNR versus drying time for RGB image

The PSNR graph shows that drying woven fabrics at 13:00 to 14:00 is far from the PSNR value of 30. Although the difference between other drying times is not significant.

The change in the RGB value of the dried cloth is shown in Table 5. Each RGB value decreases after the image is dried in the sun when compared to the RGB value of the original image.

Table 5. Image RGB value comparison.

Hour	R value	G value	B value
Original	0,446787	0,526348	0,581522
10:00 - 11:00	0,444032	0,524386	0,580532
11:00 - 12:00	0,40222	0,461564	0,495687
12:00 - 13:00	0,402778	0,477698	0,522304
13:00 - 14.00	0,3944	0,464937	0,505632
14:00 - 15:00	0,402522	0,477267	0,522082

A graph of changes in RGB values can be seen from the table above. Figure 11 depicts the value change.

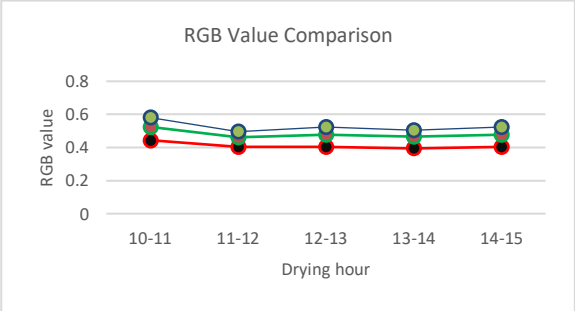

Figure 11. Graph depicting changes in the RGB value of the dried image.

Table 6 shows the magnitude of the change in RGB value at each drying hour from table 5.

Table 6. Changes in RGB Values Every Hour of Drying

Hour	R	G	B
10:00 - 11:00	0,62%	0,37%	0,17%
11:00 - 12:00	9,97%	12,31%	14,76%
12:00 - 13:00	9,85%	9,24%	10,18%
13:00 - 14.00	11,73%	11,67%	13,05%
14:00 - 15:00	9,91%	9,32%	10,22%
Average	8,42%	8,58%	9,68%

4. Conclusion

Changes in the MSE and PSNR values indicate that the quality of the weaving image has changed as a result of direct sunlight exposure. The MSE and PSNR methods are more effective in measuring the image quality of weaving using natural dyes than subjective assessment with direct vision by the human eye. The image quality of the Boti tribe's ikat weaving using natural dyes has decreased after being dried in the sun beginning at 10:00 a.m. The image of weaving is created by dyeing yarn in ground corn flour to create a white color; however, the quality of the resulting image has decreased due to exposure to sunlight. Similarly, the blue-black color is created by dyeing yarn in a mixture of nobah leaves and bark from the bauk ulu tree (from the local language). In the woven image, the average change in the RGB value is 8.42% for the R value, 8.58% for the G value, and 9.68% for the B value. The average PSNR for the RGB image is 9.44288 dB, and the MSE is 7477.52. The grayscale image has a PSNR average of 10.52 dB and an MSE average of 5832.06.

This research requires further development, particularly in the process of retrieving image data, developing methods for retrieving fabric image data, measuring the amount of drying cloth, and measuring other variables such as light intensity when taking images.

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