

Image Analysis Of Maka'if Bikomi Lokal Traditional Fabric Motifs Based On Otsu Thresholding For Pattern Identifikasi

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Abstract.

Maka'if is a traditional woven motif originating from the Dawan Miomafo community in North Central Timor, East Nusa Tenggara, Indonesia. This study investigates the segmentation and pattern analysis of the Maka'if motif using digital image processing techniques, specifically thresholding and Otsu thresholding. The dataset consisted of six original motif images that were augmented through rotational transformation to produce 30 image samples. The research process included image acquisition, preprocessing, grayscale conversion, filtering, segmentation, and performance evaluation using Mean Square Error (MSE) and Peak Signal-to-Noise Ratio (PSNR). Experimental results indicate that conventional thresholding was able to identify the basic motif structure but produced higher noise and inconsistent segmentation due to the use of a fixed threshold value. In contrast, Otsu thresholding automatically determined optimal threshold values based on image histogram distribution, resulting in clearer motif structures, lower noise, and more stable segmentation. The analysis revealed repetitive diamond-shaped geometric patterns combined with spiral and diagonal micro-ornaments as the main visual characteristics of the Maka'if motif. The proposed approach demonstrates the potential of digital image processing for the documentation, standardization, and preservation of traditional woven cultural heritage.

Keywords; *Maka'if motif; traditional woven fabric; thresholding; Otsu thresholding; digital image processing and cultural heritage preservation.*

I. INTRODUCTION

Indonesia is recognized for its rich cultural diversity, including traditional woven textiles inherited across generations [1]. Traditional woven fabrics contain aesthetic, symbolic, and social values that reflect the identity and history of local communities [2]. One of the traditional motifs from eastern Indonesia is the Maka'if motif, originating from the Dawan Miomafo community in North Central Timor, East Nusa Tenggara.

The Maka'if motif is characterized by repetitive interconnected diamond-shaped geometric patterns. Although visually similar, the motif contains variations in size categorized as small (fua mnutu), medium, and large (fua naek). The determination of motif size is traditionally based on the visual perception of weavers rather than standardized measurements [3]. The motif is produced through embroidery (mapa'uf) and ikat weaving (futus). However, the number of artisans capable of producing Maka'if motifs continues to decline, especially for the more complex mapa'uf technique.

Recent advances in digital image processing and computer vision have enabled more objective motif analysis compared to manual observation [4][5]. Previous studies have applied GLCM, LBP, SVM, and CNN for textile motif classification [6]–[10]. However, deep learning methods require large datasets and high computational resources, making them less suitable for local motifs such as Maka'if.

Image segmentation plays an important role in separating motif structures from the background. Conventional thresholding uses a fixed threshold value but often performs poorly on images with varying textures and lighting conditions [11]. Otsu thresholding automatically determines threshold values based on image histogram distribution and has demonstrated better segmentation performance [12]. Despite many studies on batik and woven fabrics, research specifically focusing on Maka'if motif segmentation remains limited.






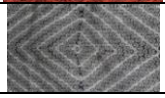
Therefore, this study proposes the use of thresholding and Otsu thresholding methods for analyzing Maka'if woven motifs. The segmentation performance is evaluated using Mean Square Error (MSE) and Peak Signal-to-Noise Ratio (PSNR). The results are expected to support the digital preservation and documentation of traditional woven motifs.

II. METHODS

2.1. Research Object

The object of this study consists of Maka'if woven motif images collected from the Miomafo region, North Central Timor, East Nusa Tenggara, Indonesia. The images were captured using a high-resolution digital camera, stored in JPG format, and cropped to focus on the main motif structure. Six original images representing several Maka'if motif variations were used and augmented through rotational transformations to produce 30 image samples. The augmented dataset was intended to improve data variability and enhance the generalization capability of the segmentation methods. Although the dataset includes variations in motif patterns and lighting conditions, it is still limited to the Miomafo region.

Table 1. Sample Dataset of Maka'if Motif Images

No	Image	Motif Type
1		Bete Miomafo Timur
2		Bete Bikomi Selatan
3		Bete Bikomi Utara
4		Tais Miomafo Timur
5		Tais Bikomi Selatan
6		Tais Bikomi Utara

2.2. Research Procedure

The research was conducted through several stages of digital image processing, as illustrated in Figure 2.

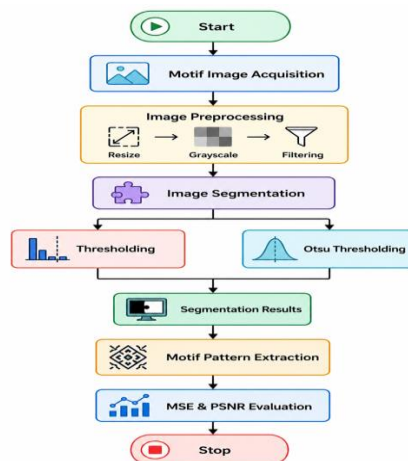


Fig 2. Research Framework Image Acquisition

The initial stage of the study involved acquiring images of the Maka'if woven motif using a high-resolution digital camera with a 24 MP (megapixel) resolution, equivalent to HD or 4K image quality. The captured images were then stored in JPG format for further processing using image analysis software.

Image Preprocessing

At this stage, several preprocessing operations were applied prior to image analysis, including image resizing to standardize image dimensions, RGB-to-grayscale conversion to simplify color information, and noise reduction using filtering techniques to minimize image disturbances. These preprocessing steps were intended to improve image quality and optimize the subsequent segmentation process.

Image Segmentation Using Thresholding

Image segmentation was first performed using the thresholding method. This technique separates object pixels from the background by applying a specific threshold value. Pixels with intensity values greater than the threshold are classified as objects, while pixels with lower intensity values are categorized as background. The output of this process is a binary image that highlights the motif pattern more clearly.

Image Segmentation Using Otsu Thresholding

In addition to conventional thresholding, this study employed the Otsu thresholding method, which automatically determines the optimal threshold value based on the image histogram distribution. The method works by minimizing intra-class variance and maximizing inter-class variance, thereby producing a more effective segmentation threshold.

Motif Pattern Extraction

Following segmentation, the resulting images were analyzed to identify the geometric structure of the motif, including repetitive diamond-shaped patterns and motif size consistency. This stage aimed to obtain the fundamental structural characteristics of the Maka'if motif that could serve as a reference for preserving traditional woven patterns. The motif pattern references were analyzed based on the average values of Mean Square Error (MSE) and Peak Signal-to-Noise Ratio (PSNR).

Method Evaluation

The performance of both segmentation methods was evaluated using Mean Square Error (MSE) and Peak Signal-to-Noise Ratio (PSNR). MSE was used to measure the error level between the original image and the segmented image, while PSNR was employed to assess image quality based on the ratio between signal and noise. Lower MSE values and higher PSNR values indicate better segmentation quality. Therefore, these parameters were used to compare the effectiveness of thresholding and Otsu thresholding methods in extracting the structural patterns of the Maka'if motif.

III. RESULT AND DISCUSSION

Image Preprocessing Results

The preprocessing stage was applied to the entire dataset consisting of 30 Maka'if motif images. This stage included image resizing, grayscale conversion, and filtering to improve image quality prior to segmentation. The grayscale conversion simplified color information into intensity values, while the filtering process reduced noise and enhanced the visibility of the motif patterns. As a result, the preprocessing stage increased the contrast between the motif and the background. This step is essential because woven fabric images generally contain complex textures and significant color variations, which can affect the accuracy of the segmentation process.



Fig 3. Original RGB Images

Segmentation Results Using Thresholding

The thresholding method was applied to the preprocessed images using a fixed threshold value of 127. This fixed threshold was used to separate motif objects from the background and generate binary segmentation results.

As shown in Figure 5, the motif patterns began to emerge after the thresholding process; however, noticeable background noise remained, and several parts of the motif were not segmented perfectly. These results indicate the limitations of the conventional thresholding method due to its reliance on a static threshold value. In Maka'if motif images with high intensity variations, this method was less effective in accurately separating motif structures from the background.

Segmentation Results Using Otsu Thresholding

To overcome the limitations of fixed thresholding, the Otsu thresholding method was employed to automatically determine the optimal threshold value for each image.

Figure 5 demonstrates that Otsu thresholding produced clearer motif structures, significantly reduced background noise, and generated more consistent segmentation results. The superior performance of Otsu thresholding is attributed to its ability to determine adaptive threshold values based on image histogram distribution. This characteristic makes the method more robust and adaptable to variations in color intensity and lighting conditions commonly found in woven fabric images.

Comparison of Segmentation Results

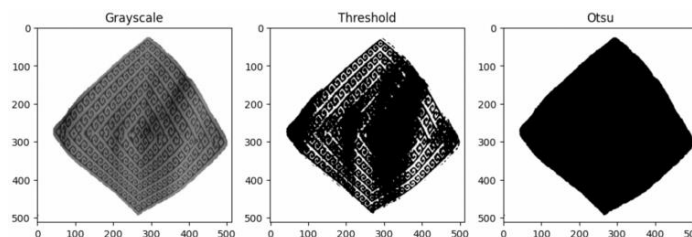


Fig 5. Comparison Between Thresholding and Otsu Thresholding Segmentation

Figure 7 presents a visual comparison between the segmentation results produced by conventional thresholding and Otsu thresholding methods. The comparative analysis is summarized in Table 2.

Table 2. Segmentation Analysis Results

Aspect	Thresholding	Otsu
Pattern Clarity	Moderate	High
Noise Level	High	Low
Consistency	Low	High

Table 2 indicates that the Otsu thresholding method performed better in preserving the geometric structure of the Maka'if motif compared to conventional thresholding. The segmentation results obtained from all 30 augmented datasets further demonstrate the effectiveness of Otsu thresholding in producing clearer and more stable motif patterns.

MSE and PSNR Evaluation

The average MSE and PSNR values are presented in Table 2.

Table 3. Average MSE and PSNR Results

Method	Average MSE	Average PSNR
Thresholding	4634.51	11.48
Otsu Thresholding	5961.26	10.56

Although several images produced higher MSE values for Otsu thresholding, visual analysis showed that the method preserved motif details more effectively. This indicates that segmentation quality should not only rely on numerical evaluation but also on the preservation of structural motif characteristics.

Maka'if Motif Pattern Analysis

The analysis revealed that the Maka'if motif consists of repetitive diamond-shaped geometric structures arranged symmetrically. Additional micro-patterns in the form of spiral ornaments and diagonal lines were also identified.

The rotational augmentation results demonstrated that the motif remained recognizable at different orientations, indicating that the Maka'if motif possesses rotational symmetry. Otsu thresholding preserved these structures more effectively than conventional thresholding.

Discussion

The findings demonstrate that preprocessing significantly improved segmentation quality. Thresholding was computationally efficient but less adaptive to intensity variations due to its fixed threshold value. In contrast, Otsu thresholding automatically adapted to image characteristics, resulting in clearer motif structures and lower noise levels.

This study focused on simple segmentation approaches because they are more suitable for small datasets compared to deep learning methods requiring large-scale data and computational resources. Although the dataset was limited to the Miomafo region and lighting conditions were relatively constrained, the study contributes to the digital preservation and documentation of traditional woven motifs.

IV. CONCLUSION

This study successfully implemented thresholding and Otsu thresholding methods for the segmentation of Maka'if woven motif images. The preprocessing stages improved image quality prior to segmentation. Conventional thresholding was able to detect basic motif patterns but produced higher noise and inconsistent segmentation due to the use of a fixed threshold value.

In contrast, Otsu thresholding automatically determined adaptive threshold values based on image histogram distribution, resulting in clearer motif structures and more consistent segmentation. The results also revealed that the Maka'if motif possesses repetitive diamond-shaped geometric structures combined with spiral and diagonal ornaments. Therefore, digital image processing approaches can support the identification, documentation, and preservation of traditional woven cultural heritage.

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