Constructing Modules for Determining Image Quality Criteria for DiTenun Mobile Application

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Abstract. Woven cloth is the result of handicrafts in the form of fabric strung from thread using looms. One form of woven cloth originating from Sumatra is Ulos. Each Ulos has its own distinctive characteristics and meanings from every motif that is produced, but the variety of motifs produced is still limited so that much economic potential have not yet been exposed. Therefore, an application is being developed that would help the weavers to produce new Ulos motifs known as DiTenun. In developing this application, a feature is needed to capture Ulos images directly from a smartphone camera that will be taken by users. Images captured directly don’t always produce good image quality, so this study investigates the most proper classification of Ulos images by their quality. Determination of input image quality can be seen from two parameters that affect the quality of an image which are blur and noise. The two parameters are detected using two different algorithms namely FFT (Fast Fourier Transform) algorithm and PCA (Principal Component Analysis). The result shows that these two algorithms are overall effective in determining the three different categories of Ulos image quality. Of the three categories, bad categories have the highest accuracy scores.

1 Introduction

Weaving is a technique in making fabric made with a simple principle, which is by combining the yarn lengthwise and transversely [3]. One form of weaving from Sumatra is Ulos. Ulos is a piece of woven cloth as a craft by women with various patterns and rules [14]. Each Ulos has its own distinctive characteristics and meanings from every motifs that is produced, but the variety of motifs produced is still limited so that many economic potentials have not yet been developed. Based on this, Institut Teknologi Del with Piksel Indonesia develop an application which will help the weavers to produce new Ulos motifs known as DiTenun [1] mobile application. One module of this application is Weaving Editor. This module is the main module where weavers and devices interact [1]. Researchers will build a module that allows the weavers to directly capture Ulos images with a smartphone camera and make it an input to produce new motives. Images captured directly do not always produce good image quality, so researchers will also classify Ulos images to determine the quality of an input image. Then, 2 (two) most common parameters, blur and noise effects are chosen in this
study. *Blur* is a common image distortion the field of photography [6] and *noise* is an image or pixel that reduces image quality in image processing. *Blur* level detection will be done using *OpenCV*, *Python*, and *Laplacian Operators* [15] while for *noise* detection researchers will use *Principal Component Analysis algorithm* from *Weak Textured Patches* [22].

## 2 Literature Review

### 2.1 Ulos

_Ulos_ means a blanket that warms the body and offers protection from cold air. _Ulos_ as a product of indigenous _Batak_ culture is a primary need, because the use of _Ulos_ is increasingly widespread, not just for warmth. _Ulos_ motifs that have existed so far are still being developed without losing the old _Ulos_ motif. In addition, _Ulos_ has more important meaning in tradition when it is used by elders and village leaders in meetings.

### 2.2 Image Quality, Blur and Noise

Measurement on image quality is important for knowing image quality. Because most images can experience distortion, it is necessary to process this distortion to improve the quality of the image. Image quality can be measured using objective and subjective methods.

The _blur_ effect can be caused by objects movements and camera movements related to _shutter speed_ when the image is taken [6]. The main reason of _blur_ effect is because the lens cannot determine the right angle and focus and therefore creates blurry image [15].

_Noise_ is a random variation of the intensity of the image and is seen as a grain in the image [4]. In general, _noise_ can occur due to several factors such as incomplete capturing image process, uneven illumination which results in uneven intensity, low image contrast, high ISO usage or physical (optical) interference, or intentional due to inappropriate processing and so forth. _Noise_ appears usually as a result of a bad deflection (_sensor noise_, _photographic gain noise_). Therefore, _noise_ means an image that have pixels with different value intensity which is not a correct pixel values.

### 2.3 Fast Fourier Transform (FFT)

Fast Fourier Transform (FFT) is a transformation that converts digital data to a frequency domain. The essence of the FFT is to break the signal into sinusoidal waves where the amount is the same as the original signal. Research shows that FFT can be applied to many things, such as electroacoustic music and audio signal processing, image processing, medical imaging, pattern recognition, computational chemistry, and others [17].

### 2.4 Laplacian Operator

The _Laplacian_ Operator is implemented to find edges in the image. The _Laplacian_ Operator is further separated into two further classifications, namely the _Laplacian_ Negative Operator and the _Laplacian_ Positive Operator [22]. The operator which is the second derivative operator will do edge detection with the aim to show the image. This operator will detect blur using variance and standard deviation using the formula below:

\[
\frac{\sum_{n=1}^{N}(x-y)^2}{n-1}
\] (1)
Description: \( x = \) matrix value per pixel, \( \bar{x} = \) average value, \( n = \) number of data

### 2.5 Principal Component Analysis (PCA)

PCA is a linear transformation to determine the new coordinate system of a dataset. Principal Component Analysis (PCA) is relatively easy to handle a large amount of data and its ability to handle complex dimensional data. One of them, PCA plays a role in image processing. The following is explained in Figure 1 image processing stage with PCA:

![Figure 1. Image Processing Phase with PCA](image)

### 3 Analysis

#### 3.1 Analysis of Fast Fourier Transform and Laplacian Operator

Parameter blur will be measured by two algorithms: FFT and laplacian operator. The steps of the algorithm are as followings:
- Image input is received and transformed in matrix format based on each pixel’s color.
- Then the image is transformed into grayscale.
- For RGB color, matrix is transformed into pixel and then convoluted into kernel 3x3
- In kernel discrete, convolution is represented in matrix 3x3, but can also be in matrix 2x2 or 2x1 or 1x2. The size is normally smaller than size of input image. Every element is called convolution coefficient.
- Convolution is performed by moving the kernel pixel by pixel. The result is stored in the new matrix. However, the side pixels are ignored so that the result will be similar with the origin.
- Next, FFT is then applied. FFT is used to determine the variance and standard deviation. This aims to identify the data spread in the input image.

#### 3.2 PCA on Ulos

PCA is used to calculate noise values in an image from selection WTP (Weak Textured Patch). Zhu and Milanfar demonstrate that the image structure can be measured effectively through the covariance matrix. The noise value in the image can be measured if the WTP on the image is selected first. The patch in the image will be represented as a matrix that represents the vertical and horizontal derivative operators. In choosing a patch there is an assumption that a WTP is a "patch or piece of image that has a relatively smooth texture" [31].
It can be seen from Figure 2, that Weak Textured Patches is the image on the right because it has the smallest eigenvalues. The procedures are followings:

- An input image is processed to measure the noise value. The image will be tested with threshold value in the gray values between 0-255
- Then the image size will be a few partition
- The extraction is performed to get the grayscale image
- Next, noise value of covariance matrix is calculated.

Then, we calculate the value of eigen, following with the sorting of the valued and patches with the smallest eigen values. This step is repeated for three times until the value of the noise is stable. Last phase is to identify the noise form the input image [22].

3.3 Analysis of the relation between blur and noise parameters with the characteristics of Ulos motif

The characteristics of certain Ulos give impact to the detection of blur and noise. This cause inaccurate classification of image quality. Sadum is one type of Ulos that own this characteristics. The good quality of Sadum may still be identified as bad image according to its own pattern that have noise-like patterns. Therefore in the experiment, such kind of Ulos clothes are excluded to avoid the bias.

3.3 Conclusion of Analysis

Based on the results of the analysis carried out, there are a number of conclusions and considerations in the implementation phase that will be carried out:

- The process of image evaluation will be carried out with three experiments, namely checking and calculating the value of one parameter first, namely evaluation images for blur parameters and image evaluation for noise parameters, and the third is done sequentially, as follows, first an inspection and calculation of the value of the blur parameters, then the results of the blur evaluation will be carried out by checking the noise parameters.
- Blur parameters are detected by the operator and FFT Laplacian algorithms while noise parameters are detected and calculated by the PCA algorithm.
- The technique may not be applicable to certain type of Ulos that has noise-like pattern.

4 Experimental Designs

4.1 Experimental Object

In this experiment, the object for test case was a picture of Ulos collected by the research team. Ulos are used as many as eight types, as follows: Bintang Maratur, Harurungan, Mangiring, Ragihidup, Ragihotang, Sadum, Sibolang and Sitoluntuho.

The entire picture of Ulos used in this experiment is 541 pictures of Ulos. Some of the images used as input data are repeated so that one Ulos can have more than one captured Ulos image. The researcher gets a picture of Ulos by taking photos of Ulos belonging to the
community in Tobasa area, owned by IT Del lecturers, students and also by visiting the factories and Ulos sellers in Tobasa area. The Ulos photography layout conducted by researchers is with Ulos stretched straight on a flat surface such as tables, floors, etc. then the researchers take pictures of all Ulos from above with different angles by smartphones to obtain pixel diversity on the Ulos picture. Ulos Classification Program is a program to determine which Ulos picture belongs to one of these eight types.

4.2 Experimental Design

The following will be explained in detail about the third stage of the experiment that has been decided by the researcher to be carried out. This experiment was carried out three times because researchers also wanted to observe which experiment were more accurate for classifying input image quality. The three experiments are:

- Evaluation of blur parameters: Detects only the blur parameters in the Ulos image. There are 3 categories of Ulos here, namely Good Data, Improve Data, and Bad Data category.
- Evaluate noise parameters: Detect only the noise parameters in the Ulos image. There are 2 categories of Ulos in this evaluation, namely Good Data and Improve Data category.
- Evaluation of blur and noise: Detect sequentially of blur then noise. First of all, the image will be evaluated through a blur parameter which has 3 categories, then the Ulos image in Good Data and Improve Data categories will be evaluated through the second parameter, noise.

The following is an explanation for the three categories determined by the researcher:

- Bad Data: datas in this category will be rejected directly by the application because even if the Ulos picture is improved it is likely to remain in Bad Data category,
- Improve Data; images in this category will be enhanced with contrast enhancement in order to get to the next process, namely noise and image checking,
- Good Data; images in this category of Ulos will be directly checked for noise.

Fig. 3. Process Ulos image evaluation based on blur parameters and Image Evaluation process Ulos based on noise parameters

Programs and images that have been prepared for this experiment are:

- Blur Detection Program in the Spyder IDE.
- Noise Detection Program in MATLAB IDE.
- Image of Ulos captured from smartphone; as many as 541 images.
- Contrast Enhancement Program and Denoising Program.
- Ulos Classification Program. This program is an algorithm to determine which Ulos picture belongs to one of 8 types described in Chapter 4.1.

The following will be explained about the experiments carried out in detail:

- Blur Parameters. This sub-chapter will discuss Ulos image evaluation observations for blur parameters only. This observation is to ascertain the threshold range in those images in order to determine the Ulos classification. The process of analyzing the blur parameters will be carried out like Figure 3. The Accuracy Calculation in Step 6 on Figure 3 is done per category, following in equation (i), (ii), and (iii) the formula for this calculation will be explained:

  (i) **Bad Data Accuracy** = number of Ulos images whose image classification according to **Ulos Classification Program** is wrong divided by total **Ulos** picture in the **Bad Data** category x 100%

  (ii) **Improve Data Accuracy** = number of images of **Ulos** whose classification according to **Ulos Classification Program** is correct divided by total **Ulos** overall image in the **Improve Data** category x 100%

  (iii) **Good Data Accuracy** = number of **Ulos** images whose classification according to **Ulos Classification Program** is correct divided by total **Ulos** picture in the **Good Data** category x 100%

- Noise Parameters. This sub-chapter discusses Ulos image evaluation observations for noise parameters. Observation is to further ascertain the threshold range in the image in order to determine the classification. The process of analyzing the noise parameters in the Ulos image that will be carried out by the researcher will look like Figure 3. This accuracy calculation is carried out per category, following in equation (i), (ii), and (iii) the formula for this calculation will be:

  (i) **Bad Data Accuracy** = number of Ulos images whose classification according to **Ulos Classification Program** is wrong divided by total Ulos picture in the **Bad Data** category x 100%

  (ii) **Improve Data Accuracy** = number of images of Ulos whose classification according to **Ulos Classification Program** is correct divided by total **Ulos** overall image in the **Improve Data** category x 100%

  (iii) **Good Data accuracy** = number of **Ulos** images whose classification according to **Ulos Classification Program** is correct divided by total **Ulos** picture in the **Improve Data** category x 100%

- Blur and Noise Parameters. This section discusses the evaluation of images for blur and noise parameters. The observations is to understand the threshold of an image for blur and noise. In Figure 4, Ulos image evaluation stage is displayed based on blur and noise parameters:

![Fig. 4. Evaluation process Image blur and noise](image-url)
5 Experiment Results and Discussion

5.1 Blur Parameter Experiment Results

In the testing phase of a single parameter experiment, the blur parameter can be as follows:
- *Bad Data* Accuracy obtains 67.72%
- *Improve Data* Accuracy obtains 16.03%
- *Good Data* Accuracy obtains 26.41%
- *Ulos* data from the *Bad Data* category that has been through the Contrast Enhancement process, obtains accuracy of 88.31%
- *Ulos* data from the *Improve Data* category that has been through the Contrast Enhancement process obtains accuracy of 15.38%
- *Ulos* data from the *Good Data* category that has been through the Contrast Enhancement process obtains accuracy of 14.67%

5.2 Experiment Results Noise Parameter

- Data in *Improve Data* classification obtains accuracy of 30.79%
- Data in *Good Data* classification obtains accuracy of 29.68%
- Data in *Improve Data* classification who has gone through denoising process obtained accuracy of 14.62%
- Data in *Good Data* classification who has gone through denoising process obtained accuracy of 20.67%

5.3 Experiment Results on Blur and Noise Parameters

In the last experiment, evaluation by combining blur parameters and noise parameters obtained the accuracy level as follows:
- *Ulos* data from 3 categories of *Ulos*: *Bad Data*, *Improve Data*, and *Good Data* that have been through the *Blur* checking process checked the level of accuracy in the classification of *Ulos* category improvement category obtained 17.62% accuracy
- *Ulos* data from 3 *Ulos* categories namely Bad, Improve, and Good that had been through the first checking process, namely noise was checked for accuracy at classification of *Ulos* good category obtained accuracy of 22.16%

5.4 Experimental Results of Image Evaluation

<table>
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<tr>
<th>Table 1. Experiment results for blur parameters</th>
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<tbody>
<tr>
<td>Category</td>
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<tr>
<td>Bad</td>
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<tr>
<td>Improve</td>
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<td>Good</td>
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<th>Table 2. Results of noise parameter experiments</th>
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<tr>
<td>Category</td>
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<td>Improve</td>
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<td>Good</td>
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From the analysis, experiments and evaluations that have been carried out by the researcher to obtain threshold provisions on blur and noise parameters, it can be seen in Table 1 for blur parameters and Table 2 for noise parameters as the final threshold determination.

5.5 GUI Implementation Results

Fig. 6. Display of blur and noise detection feature on Ulos image

The following in Figure 6 are the results of the implementation of the GUI that has been done by researchers. The GUI is made for the purpose of making it easier to detect noise and blur from an Ulos image.

5.6 Discussion of Results

The following will be discussed about the results that have been obtained from experiments and evaluations carried out, namely:

- On the blur and noise parameters improve and good categories have not obtained high accuracy due to several things such as:
  - Manual classification conducted by researchers still has limitations in the improve and good categories, namely researchers are still difficult to categorize input images that can be improved (improve) with a good category (good) by naked eye.
  - The dependence of this module with other modules such as the classification enhancement module and module makes the experimental results have a low accuracy value because the level of accuracy in the other modules used is still categorized as low and not accurate. There is no module for enhancement module that can improve blur, so researchers use a contrast enhancement process to brighten the input image so that it becomes one of the things that affect the level of accuracy in evaluating images. Meanwhile, the noise parameter is used by denoising process. This process is suitable to be used to reduce the noise value in the input image. Whereas in the classification module that affects the level of accuracy is the existence of several limitations of the module such as: the amount of data and the variation of data that is still used in a minimal amount and the similarity of Ulos image data in this module which causes the studied data to be considered similar to the machine.
  - In the blur parameter with bad category has a high level of accuracy supported by manual categorization which is easier because it can be categorized more clearly.
  - From the experimental results it can be concluded that the classification of input image quality using two blur parameters and noise is better because input image processing is more accurate.

6 Conclusions and Suggestions

In this chapter is explained the conclusions and suggestions in subsequent studies obtained from the entire image evaluation process that will be used in the DiTenun mobile application.
6.1 Conclusions

From this Final Project research work, researchers have presented the results of the experiment and research evaluation. Although it has some drawbacks, the researchers were able to draw the conclusion that:

- This study uses two parameters, namely *blur* and *noise* to measure input image quality, but the experimental results show that *Ulos* classification is better using two parameters of *blur* and *noise* due to higher accuracy compared to using just one *blur* or *noise* parameter.
- This research has produced a module that is able to classify input images into three categories: *Good*, *Improve*, and *Bad* categories.
- Of the three categories, bad categories that have the highest accuracy scores and for the other two categories, *Improve*, and *Good* are still low because two things: manual categorization is still difficult and there is still reliance on other research modules that have not been completed, namely enhancement modules and modules classification.

6.2 Suggestions

In this sub-chapter, it is explained about suggestions for conducting further research. These suggestions are as follows:

- For further research from this research, it is expected that researchers will explore the *Ulos* image so that authors are able to get pixel values on the input image through a machine learning approach because through machine learning, the threshold will follow the input image as existing data.
- Doing research using *Ulos* images captured from a digital camera is no longer an image captured by a smartphone camera because the pixels on a digital *Ulos* image are better than those captured by a smartphone camera.
- Subsequent research is also better analyzed based on the type of *Ulos* because in this study obtained several different types of *Ulos* such as *Ulos* Sadum which has many spots so that it is considered to have a lot of *noise*.

References