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# 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 the 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 electroaccoustic 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:

$$= \frac{\sum (x - \bar{x})^2}{n - 1} \qquad (1)$$

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:

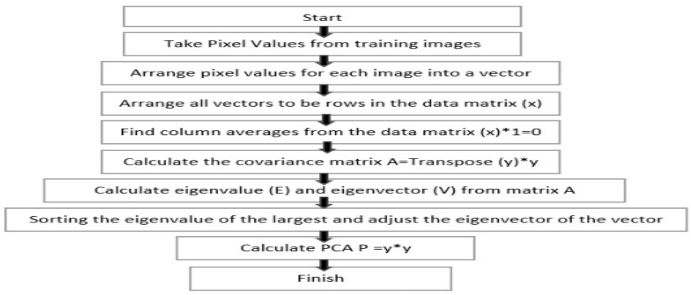


**Fig. 1.** Image Processing Phase with PCA

## 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 tranformed 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 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].

(a) $s_1^2 = 21830.30$ (b) $s_1^2 = 14109.05$ (c) $s_1^2 = 31.12$

**Fig. 2.** Patches with eigenvalues

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 sixe 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 valyed 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 identifie 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*.

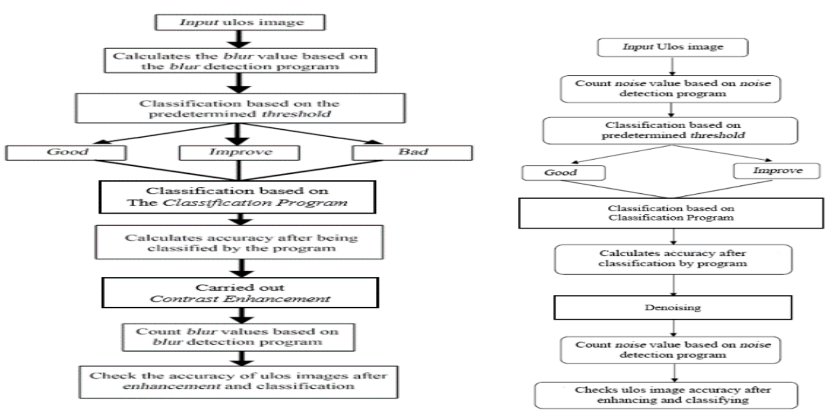


**Fig. 3.** Process *Ulos* image evaluation based on *blur* parameters and Image Evaluation process *Ulos* based on *noise* parameters

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 f or *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 discuss *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*

# 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 1.** Experiment results for *blur* parameters

| Category | Threshold | Accuracy |
|---|---|---|
| Bad | 0 – 400 | 67,72% |
| Improve | 400 – 1500 | 16,03% |
| Good | > 1500 | 26,41% |

**Table 2.** Results of *noise* parameter experiments

| Category | Threshold | Accuracy |
|---|---|---|
| Improve | 0 | 14,62% |
| Good | ≥1 | 22,16% |

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

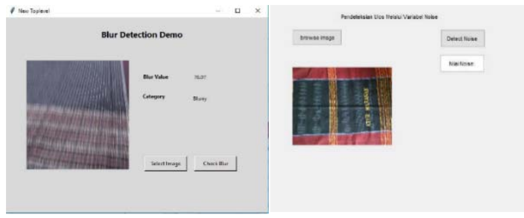


**Fig. 6.** Display of blur and noise detection feature on *Ulos* image

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*.

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