Batik Fractal : Traditional Art to Modern Complexity

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Abstract

Fractal Dimension Analysis with Fourier Transformation for Batik shows the presence of fractal with range between 1 and 2. The Isen process (filling smaller motifs after the bigger motifs are done) is a significant factor which made the Self Affine,a fractal's characteristic, appear. Analysis of Variance/ ANOVA Test for Fractal Dimension classified several batiks that have similar value, according to their motifs and their place of origins. Furthermore, Fractal Dimension spreads almost symmetrically in every angle, except for banji motifs where the symmetry appears less. According to their place of origin, Yogya and Solo has similar Fractal Dimension with batik from Madura and Garut, but Madura and Garut themselves has different Fractal Dimensions.

The presence of fractal in batik indicates the presence of complexity in this traditional art. The complexity emerges because the effort to obey pakem rule (symbolic meanings, harmony, symmetry) and media limitations (canting, wax)

Keywords: batik, isen, fractal, Fractal Dimension, Self Affine, Fourier Transformation

1. Batik and Fractal Dimension: An Introduction

Batik is considered to be a textile art. The character of this particular art extents from ethnography, archaeology, anthropology, tribal art, primitive art, and traditional visual art. Basic technique in producing batik has been widely known, such as India (bandhana), China (miao), Japan (rokechi,katanori), Russia (bokhara), and Malay region (plangi, palekat).

Batik motifs itself evolves according to their place and time, such as keraton (solo, yogya, majapahit), India (patola and jlamprang), Islam (anti-anthromorphic, arabesque, flat forms), China (bright colour, floral, phoenix, lions and dragons) and even dutch influenced Indonesia.

Because batik has certain symbolic meaning, then each object which become batik ornamentations has mythological meanings. Animal motifs use many bird objects due to its flight

capability that can connect between heaven and earth. So does lotus motif, a water plant, as a manifestation of life since it grow upward to the sky from the depth of water.
There are two main topics in defining batik: as a process and as motif. Process is the technic in craftsmanship to produce batik by resist-dye technique. The motifs itself is the ornaments found in batik, which are classified as parang, geometry,banji, spreading plants, water plants, flowers and animal.
Batik is not an ordinary textile art. Inside we found functional value. This value creates different batik motifs. For example the motifs between peasant and noble, coastal and interior, everyday and ritual are not similar to represent the difference of each value.
In aesthetic side, the quality is not based on the judgment of being good or bad, but in its effort to obey the pakem rule. As a form of decorative art, the ornament or isen is not merely to fill the space left from the batik motifs, but rather as to give specific value. Indeed, to understand the batik motif it is not enough to disentangle the motifs to just merely dots, line, colour or shape, but also its meaning behind it.
In Complexity Theory, the emergent of Chaos are marked by the presence of fractal. Fractal stands between order and chaos, in which case are known as in Edge of Chaos. Fractal can be seen by its characteristic, which is Self-Similarity and Self-Affine. In Self-Similarity an object has geometrical form which resembles the object's detail in smaller scale. In Self Affine an object has detail which resembles the object, although not necessarily be similar in every aspect.
This paper examines the process of batik in producing batik motifs which has fractal characteristic. The initial Hypothesis of this research is that batik has fractional fractal dimension, which means that batik is Fractal. The hypothesis' background is the making of isen in batik motifs. Isen itself is the process of filling the space left by main motifs with ornamentations.
The measurement of fractal dimension itself is useful for analyzing in different fields. Such as heart failure detection (Teich et al), river flows (Szustalewicz et al), transportation (Dorfman), brain tumor detection (Marsh), fish's neuron in brain (Isaeva), retinal eye scan (Ewe et al).
The paper thus explores the possibility of creating batik through Generative Arts. If batik is indeed fractal, then it is appropriate to produce batik motifs using the same means. The algorithm is as follow:

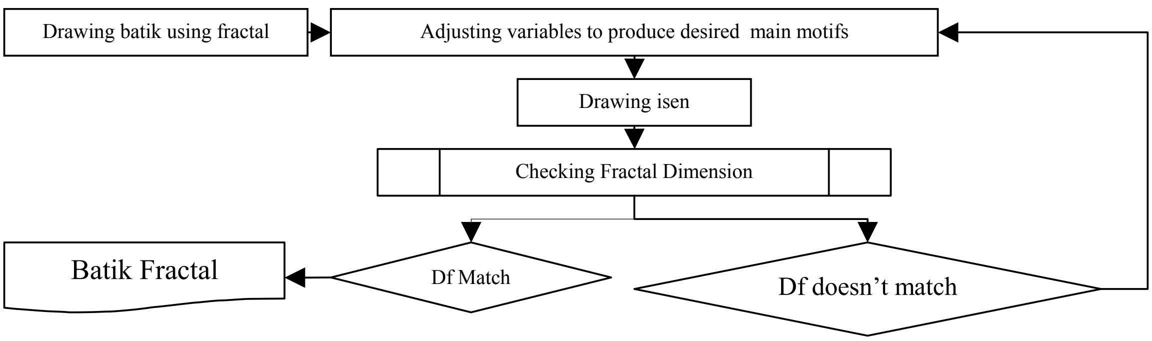

Figure 1, algorithm of creating batik using fractal as mean of Generative Art

The paper's systematic consists of Preface, Methodology, Analysis, Conclusion and Suggestion for Further Works.

2. Methodology

Fractal dimension are defined by this expression:

$$D = \lim_{\epsilon \to 0} \frac{\log N(\epsilon)}{\log \frac{1}{\epsilon}}$$

Suppose Z is a picture with M X N size, with value for each pixel is f(x,y), then:

$$X = [f(x,y)]$$

Indeed, the Fourier Transformation will be:

$$F(u,v) = \frac{1}{MN} \sum_{x=0}^{M} \sum_{y=0}^{N} f(x,y) e^{-j2\pi(ux/M+vy/N)}$$

$$G(u,v) = F(u,v) - \bar{F}, \bar{F} = \frac{1}{MN} \sum_{u=0}^{M} \sum_{v=0}^{N} f(u,v)$$

Value for each pixel is defined as G, whereas:

$$W = \|G(u,v)\|$$

Value for each W are grouped in angle parameter (with different m angle) and distance (different n length), with (x_c, y_c) reference, thus:

$$W(\theta_i, R_j) = \left\{ w_{uv} \mid \tan^{-1} \frac{v-y_c}{u-x_c} \in \theta_i, \sqrt{(u-x_c)^2 + (v-y_c)^2} \in R_j \right\}$$

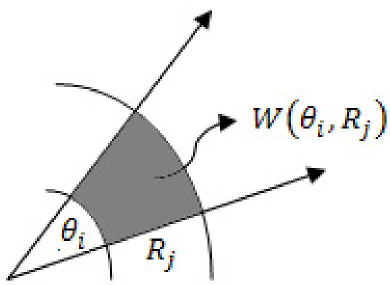

Figure 2, coordinate distribution

$$D_f(\theta_i) = \alpha_i, \psi_i = -\alpha_i R + \delta_i$$

$$\psi_i = \left\{ \frac{1}{\varpi_i} \sum W(\theta_i, R_j) | j = k, \cdots, n \right\}$$

$$R = \{R_j | j = k, \cdots, n\}$$

$$Df = \{Df(\theta_i) | i = 1, \cdots, m\}$$

$$DF = \frac{1}{m} \sum_{i=1}^{m} Df(\theta_i)$$

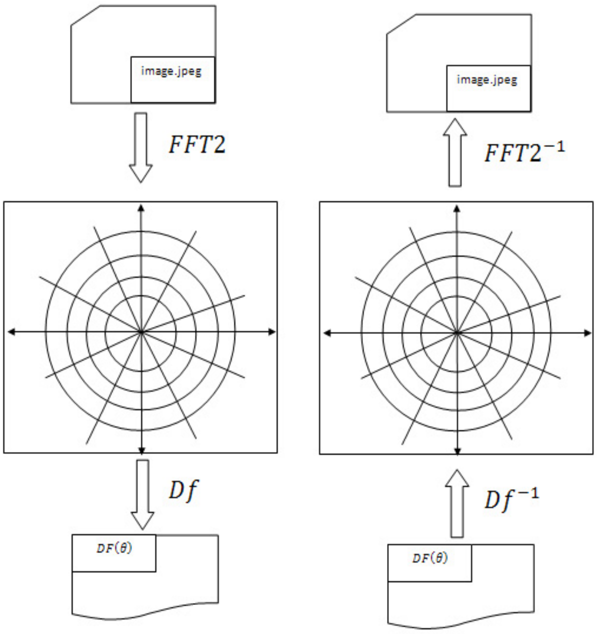

Figure 3, Df algorithm

3. Analysis

Data in this analysis are from several region that produces batik in Java from Batik Komar collection and Nian Djoemena. Picasso paintings (from 1989-1940) are included as comparative object to test the validity of Fractal Dimension analysis. Each picture in this analysis has 200 X 200 pixel size, with m = 24 and n = 30.

To further illustrate Fractal Dimension in objects, below are several picture along with the analysis of Fractal Dimension.

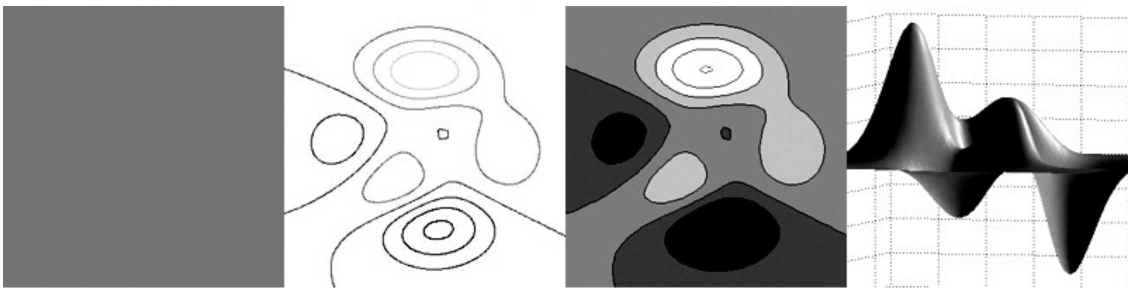

Figure 4,
Fractal Dimension in each object that does not has fractal characteristic; empty space (df=0), line contour (Df=1,099), plane contour (Df=2,011), and sphere (Df=3,040)

Based on Fractal Dimension Analysis trough Fourier Transformation, it is shown above each dimension is not natural numbers whereas they supposed to an integer of 1 or 2. The explanation is because the Analysis also calculates angle parameter and length from each point to centre

point of picture. But in general the rounding off to nearest natural number show that Fourier Transformation is able to calculate the dimension from each picture. Object in picture 3 which depicts three dimensional forms from mathematical equations can even be calculated as three dimensional object although in two dimensional media. Then what would happen to object made by humans?
From Figure 4 it is shown that aspect of colour is important in analyzing Fractal Dimension. The change from 0 dimension (empty space) to 1 dimension (line) needs curve to fill the empty space. Furthermore the change from 1 dimension to 2 dimension (plane) needs colour to fill the space. And the change from 2 dimension to 3 dimension need certain colour gradation for giving the effect of 3 dimensional forms.

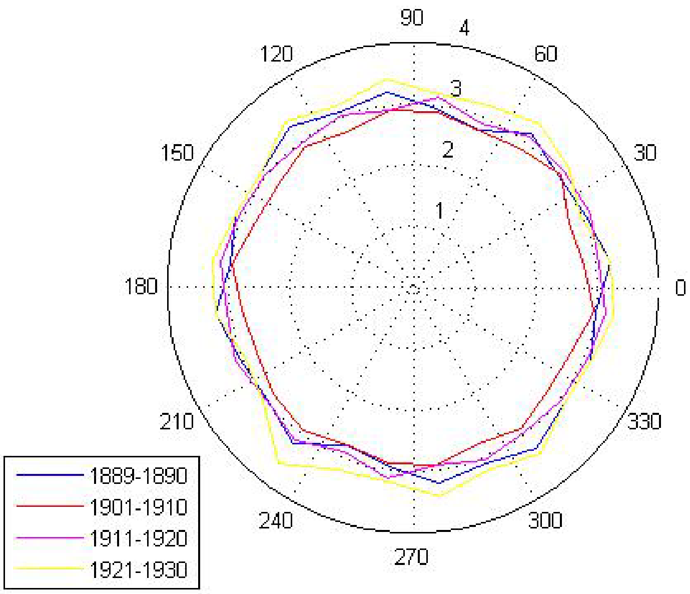

Figure 5
Fractal dimension of Picasso's work according to time period. The Fractal dimension for each period is near 3, which is conforms to the fact that Cubism depicts 3 dimensional object.

In Picasso's work, there are slight differences in Fractal Dimension in each period. Although it is still consistent with Cubism style which has ranges around 3, the 1921-2930 period has higher dimension. It means that the detailing level in that period is particularly high. But in general all of Picasso's work does not show the presence of fractal. What about batik?

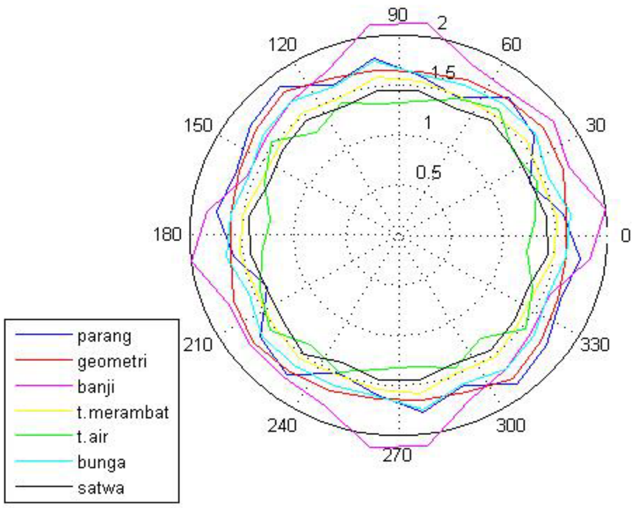

Figure 6a, motif

Batik is different than Picasso's painting. It is clearly evident by comparing the Figure 4 with Figure 5a. It is seen that batik motifs' Fractal Dimension ranges between 1 and 2, even though the object of the batik motifs is in 3. It shows that the pakem rule in making batik is to draw objects which has dimension between 1 and 2, specifically in the range of 1.5 In other words batik motifs appearance is between a curve and a plane.

The value of this particular dimension shows the presence of high detailing level in batik. This is because the "isen" process in batik making. In this process, the empty space left by the main motif are being filled by ornaments that fits the main motif. In batik, the isen is not just merely filling the empty space but also a way for perfecting the entire motifs and giving batik its meaning. From its symmetry by seeing the variance value (distribution of its average value), it shows that banji motifs (batik index no. 62-65 in appendix) are the most asymmetrical compared to other motifs, with highest variance level for Fractal Dimension of 0.0307. It can be seen by the fluctuation of Fractal Dimension in angle 0, 90, 180, and 270, which is close to dimension 2 (plane). It raises interesting topic about the meaning of banji motifs itself, which closely related to the tradition of weaving rattan to create planar forms.

motif	mean(Df)	var(Df)
parang	1.6623	0.0194
geometry	1.6912	0.0030
banji	1.8313	0.0307
Spreading plant	1.5095	0.0021
Water plant	1.3952	0.0094
flower	1.6358	0.0031
animal	1.4180	0.0017

Table 1,
Fractal dimension and the symmetry of each motifs

Besides banji motifs, according to Table 1 all motifs are symmetrical. In symbolic meaning the symmetry itself symbolizes harmony and balance. Even though the object in batik motifs, such as animals or plants are 3 dimensional forms, but the drawing style makes these object less than 2 dimensional and symmetrical. For example In Kupu Gandrung/ Butterfly in Love motifs (batik index 167) which shows the effort to present the symmetry of butterfly by depicting the form in spreaded wing. In Kawung motif (batik index 34-36). Or in Ceplokan flower motifs (batik index 121-126), the effort to create symmetry is being done by drawing batik motifs seen from above. Interestingly, the most symmetrical condition are being shown by animal motifs, which has lowest variance value in Fractal Dimension.ANOVA Test for Fractal Dimension in Figure 6b and 6c shows four categories of different Fractal Dimension of batik motifs.The first category is water plant and animal with Fractal Dimension of 1,4, second is spreading plant of 1,5, third is parang, geometry and flower of 1,65, fourth is banji of 1.8.

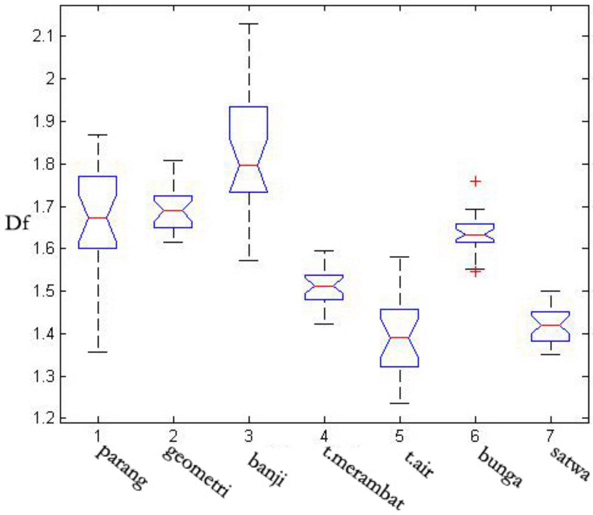

Figure 6b,
ANOVA Test for each motifs, which shows their proximity to other motifs

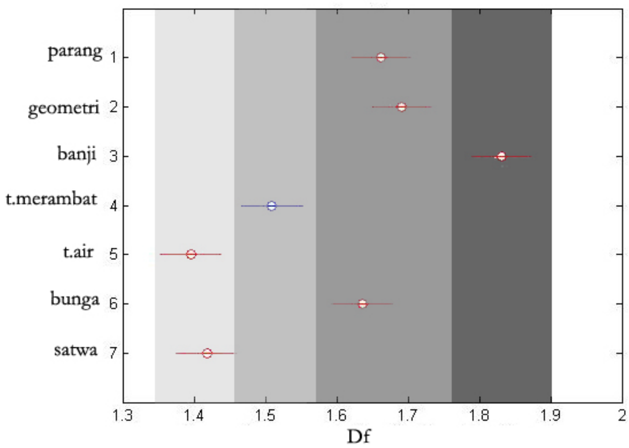

Figure 6c,
Anova Test which shows 4 categories with different Fractal Dimensions.confidence interval 95%

Batik motifs produces different Fractal Dimensions. But the difference is still consistent with batik motifs in general whereas batik is fractal with its dimension ranging from 1 to 2. The next examination would divide batik into groups according to their place of regions they produce. In everyday life, people often divide batik into their region it produces, such as Cirebon, Yogyakarta, Solo, Tasik, etc. How would these effect batik's Fractal Dimension?
Fractal Dimension of batik samples for each region with ANOVA Test shows that each regions has different dimensions. Anova analysis categorizes batik according to its Fractal Dimension. In first category with Fractal Dimension of 1.1 is only from Batik Cirebon as its member. In second category of 1.3 – 1,4 are from Batik Solo, Garut, Yogyakarta and Madura. In third category of 1.25 are from Madura, Yogya, Solo as its member. Fourth member of 1.4 are from Madura, Yogya, Solo. Fifth member of 1.6 are from Lasem and Tasik.
In second, third and fourth it shows that Fractal Dimension of Batik Madura and Garut has resemblance with Batik Yogya and Solo. However Batik Madura and Garut are different in their dimension. This means that Batik Yogya and Solo influenced Madura and Garut. In relation with its geographic place this analysis will prove interesting, since Solo and Yogya are situated in Central Java, whereas Madura is in the east, and Garut is in west.
The ANOVA Test also shows that Batik Cirebon has singular Fractal Dimension, contrary with other region. The result is in accordance with the fact that ornamentation of Batik Cirebon has different perspective in principal and expression.
Fractal Dimension Analysis of batik, be it in motifs or regions, shows the presence of Fractal. This resulted in interesting question: why does Batik has Fractal properties? To answer this, we first must examine the characteristics of Fractal. Self-Similarity and Self Affine of an object means that smaller scale in detail it exists geometry which resembles the object. The Isen Process gives significant contribution in detailing in smaller scales. Because the isen does not have to be necessarily the same with the motif, and Batik often has isen which resembles its main motifs but not in scale or angles, then Self-Affine characters is most likely to be found in Batik. Another interesting part in batik process is in the distribution of fractal properties in Batik, which is uniform. This can be answered when we remember the concept of batik as a symbol of harmony and balance. In closer observation, the process of creating batik involves the reduction of dimension of objects that has three dimensional properties (animal, floral motifs). Not only that, the resulted dimension has fractional properties. Besides the involvement of pakem rules, it also related to media and tools of producing batik: textiles, canting to wax the textiles, and wax. The limitations of media and symbolical meaning behind Batik makes its dimensions exists between 1 and 2.

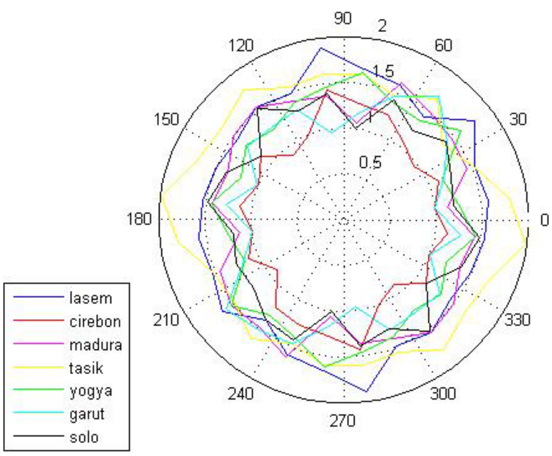

Figure 7a,
Fractal dimension of batik according to their regions.

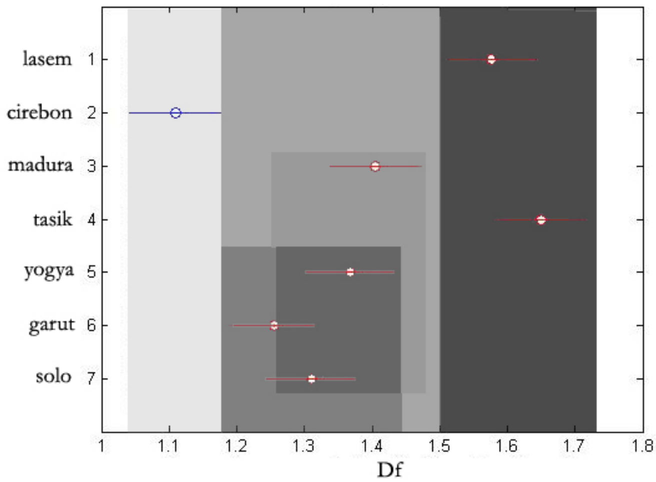

Figure 6b,

Anova testing for classification of Fractal Dimension according to region, which resulted in five category. Batik Cirebon has Fractal Dimension which is different than batik from other regions. While Fractal Dimension between 1.2 and 1.5 has classification that is juxtaposed between Madura, Yogya, Garut and Solo. Batik Lasem and Tasik is in Fractal Dimension of 1.5 – 1.7 classification.

4. Conclusion and Suggestions

Fractal Dimension Analysis through Fourier Transformation is able to calculate dimensions from two dimensional pictures. The analysis for classification of batik according to motifs and regions shows that Batik has fractal properties, which are evident in their dimension properties (1.5). Batik stands between the curvature and plane. Furthermore the fractal properties shows high degree of details. The details in different scales are the result of Isen process in Batik.

In terms of Generative Arts, Fractal Dimension can be used to control the batik that is produced using fractal. Pixel People Group of Indonesia has develops computer software to produce batiklike forms that uses Fractal Dimension to control the batik motifs. The batik is called Batik Fractal. Using PHP language program, this software aims to design batik motifs in contemporary or traditional means. The nature of PHP as free software also allows its user to develop this program to future needs.

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