

Computational Batik Motif Generation

Innovation of Traditional Heritage by Fractal Computation

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Abstract

Human-computer interaction has been the cause of the emerging innovations in many fields, including in design and art, architectural, technological artifacts, and even traditional heritage. In the case of Indonesian traditional heritages, the computation of fractal designs has been introduced to develop batik design – the genuine textile art and skill that becomes a symbol of Indonesian culture. The uniqueness of Batik, which depicted in the richness of its motifs, is regarded as one of interesting aspect to be researched and innovated using computational techniques. Recent studies of batik motifs have discovered conjecture to the existence of fractal geometry in batik designs. This finding has given some inspiration of implementing certain fractal concepts, such escape-time fractal (complex plane) and iterated function system to generate batik motifs. We develop motif generator based upon the Collage Theorem by using Java™ platform. This software is equipped by interface that can be used by user to generate basic patterns, which could be interpreted and painted as batik motif. Experimentally, we found that computationally generated fractal motifs are appropriated to be implemented as batik motif. However, human made batik motifs are less detail and some of them differ significantly with the computationally generated ones for tools used to draw batik and human aesthetic constraints.

Keywords: batik, fractal, motif generator, human computer interaction

1. Introduction

Human-computer interaction related to productivity and innovation has yielded a lot of discussions and impacts in improving a lot of progress in the development of user-friendly software (Zhapiris & Ang, 2009). However, our age has witnessed that computational technology has changed a lot more than we might like to imagine (Asaolu, 2006), be it culture (Edward, 1994), economy (Vaaler & McKnight, 2000), politics (Friedman, 2005), and even changed the way we see ourselves, and the social life surrounding us (Kraemer, *et al*, 1995). A lot of theoretical discoveries in science and technology nowadays are easily conveyed and thus implemented to cope with some problems or simply just boost our living performance.

Batik is a famous and unique traditional heritage from Indonesia. Its uniqueness comes from its production process – which known as “mbatik”, its motifs, and its values. Since cultural and art product could become an economic product (Heilbrun & Gray, 2004), as artistic and unique fabric product, batik could be a very valuable product economically, even in the modern era like today. However, besides as a economic product, batik is considered having an astonished characteristic on its motifs. Batik motifs and ornamentation, which is born and constructed from cognitive process of human being when she drawn her surrounding nature, is found to have a very interesting complexity degree. This feature is regarded as one of interesting aspect to be researched and innovated using science and technology.

Recent development in science and technology has made simulation growing natural process *in silico* becomes possible. It is also possible to generate Batik motifs and ornamentation – which found has a fractal property in its complex geometry – computationally. Situngkir (2008) have been classified innovation types of batik motifs and found that batik motif could growth computationally by incorporating fractal generation algorithm, such as iterated function system, complex plane, etc.

In order to design, evaluate, and implement computational systems for batik motifs generation, the algorithms mention above have been implemented in Java™ platform. This software is constructed to explore possibilities on batik motifs generation, and to evaluate the implementation of these motifs in *mbatik* process.

The interaction of this computing platform with users in generating new batik motif is conducted in form of workshop involving nine senior high school students. Interestingly, we have found that students could be easily perceived whether computationally generative motif resulted by fractal-generating software is appropriate batik motif or not. The emergence patterns of batik design also have found when these motifs are painted to fabric material by using traditional batik process. The paper reports the evaluation of the workshop.

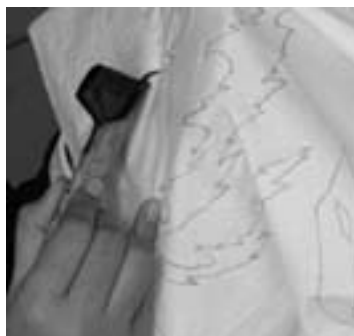


Figure 1.

Mbatik process uses “canting” to draw the hot wax to fabric to be resisted in the coloring process

2. The Implementation of Computational Motif Generation on Batik Process

Iterated Function System based upon Collage Theorem, proposed by Michael Barnsley (1988) is proposed as one concept to analyze the fractal properties of Batik motif. The algorithm base upon concept in which one of a few simple rules is selected at random and applied to a dot, to yield a new dots iteratively, as it has been implemented as motif generator (Situngkir, 2009).

However, the implementation of the generated motif as the source for batik design is considered as a new field, and thus should be tested and developed further to provide the appropriate computer system design, methods, and tools for *mbatik* process. In order to evaluate the usage of computational system, i.e. the algorithm and the software, to be implemented as batik, we deployed the interaction scheme of the computer system with human practice in traditional batik process (figure 2). The interaction scheme as we can see in figure 2 is conducted in a workshop involving nine senior high school students that act as software user and batik painter as well.

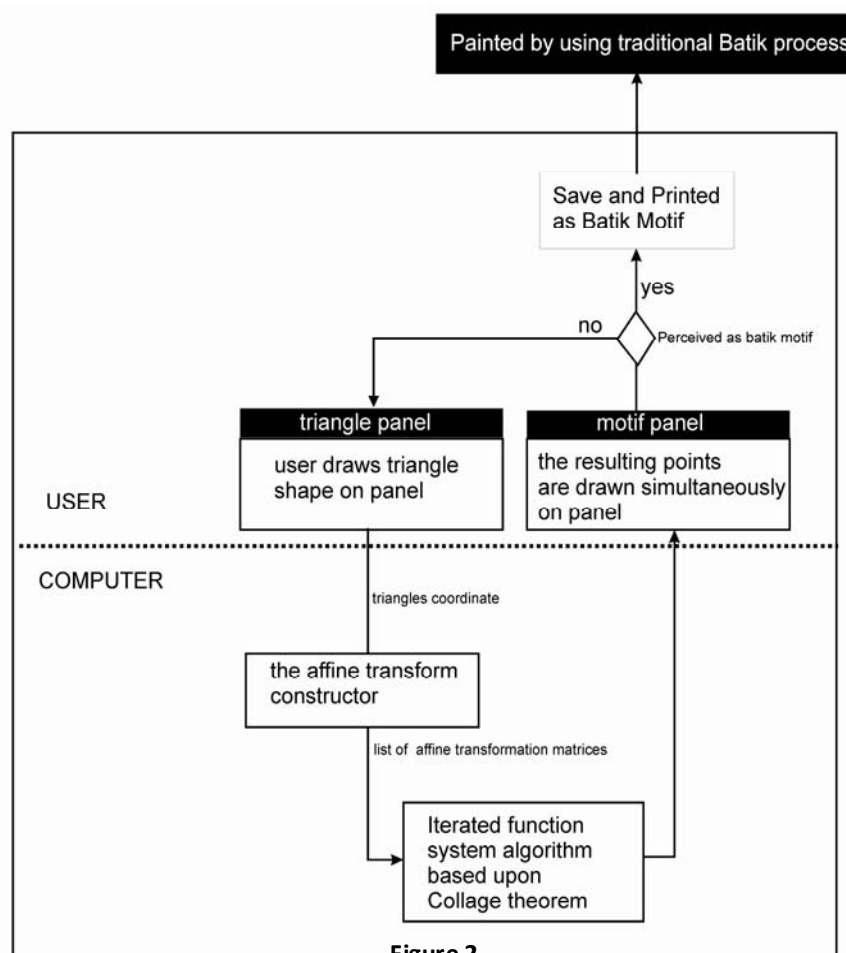


Figure 2
The usage of computational motif generator based upon iterated function system in *mbatik* process

In this workshop, all students are instructed to use the software with the guidance of software instructor. Before using the software, students are informed about fractal, including its concept and several fractal generation algorithms. Therefore, we can assume that all students are having a basic and general understanding about fractal before they use the software. In order to generate the motif, the students only draw several triangles on screen to determine all affine transformations of

the iterated function system. Generated motifs which perceived as batik motif, then printed and painted further on fabric by using traditional batik process, as follows (visualized in figure 3):

1. Manually drawing the printed of generative motif to the fabric by using pencils.
2. The writing process of motif using hot wax and painting device called “canthing”.
3. The fabric is coloring using certain fabric color materials – the waxed part in the pattern becomes the part with no color (resisted).
4. Wax residue is discarded by boiled it in boiled water – this can be followed by the second coloring process for two or more colors.

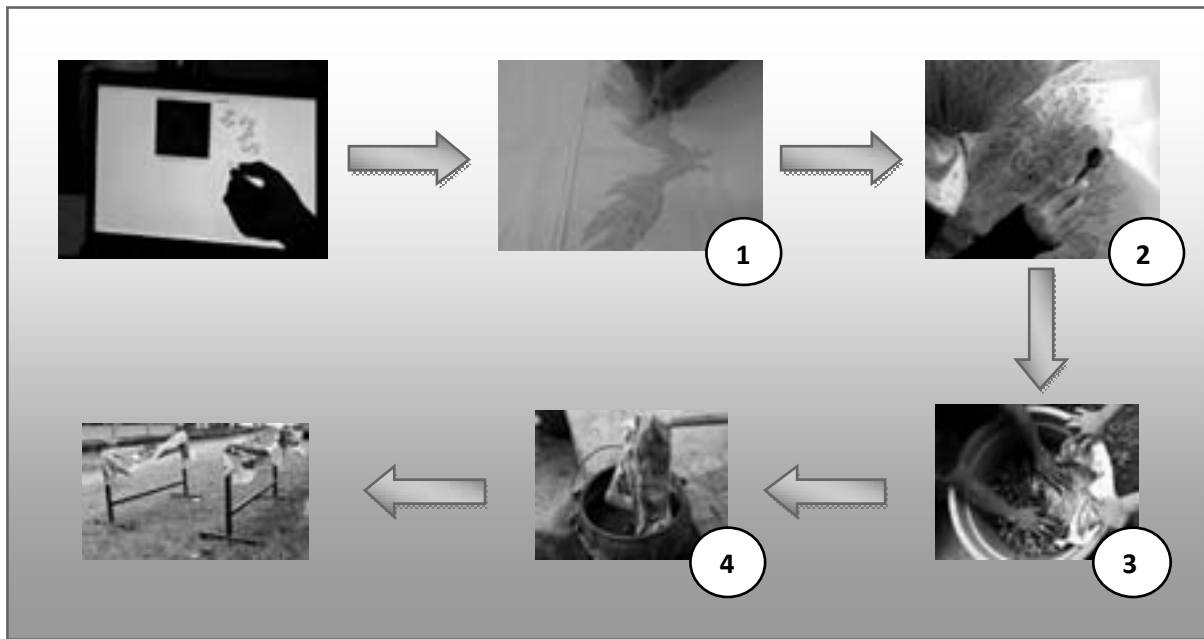


Figure 3

Acquisition of Computational Fractal Computing in Indonesian m batik process.

Batik cloths produced by hand-made process and using computationally generative fractal patterns as basic motifs are depicted in the appendix. Interestingly, the hand-made batik designs are emerging (sometimes) unexpected and interesting patterns. The batik design produced by human and computer interaction are emerged as a new kind of batik pattern, which is very interesting to analyze further in order to see the implication of human-computer interaction on innovation process of traditional heritage such as batik.

The nature of computationally generative motif is somewhat different with human made motifs. Pattern of motifs resulted from several fractal generating algorithms are determined by a set of hundred or even thousand points drawn on computer screen pixels, while human made motifs is constructed as continue line drawn by certain materials and tools used for drawing. Nevertheless, in order to paint generated motif to fabric using batik technique, constraint by several aspects, such as human biological constraints, *e.g.*: capability of human eyes to detect the edge of shape, her cognitive capacity, her cultural and educational backgrounds, etc. These human factors related to creativity have made the implementation of computationally generative motif to batik medium sometime resulting unexpected batik design (McCormack and Dorin, 2001).

Fractal generating model are just merely pattern of discrete points drawn on screen pixels. The human capabilities to infer and detect the edge of from variety of object (Yuille, *et al*, 2004) still hold an important role to perceive the shape from these generative patterns. However, the limitations that come from the batik drawing tools, i.e. pencil and “canthing” make the hand-made motifs is less detail relative to the printed ones. The pattern and characteristic of each human-made batik design (see appendix) that try to mimicking the computational fractal pattern could be influent by several factors, such as: (1). the individually inference process of motif pattern by batik designer, which could be depend on the cognitive factor, his experience, and cultural background. (2). the creativity of each batik designer to decide the usage of the generative motifs, be it as *klowongan*, *isen-isen*, or harmonization ornamentation, in his batik design (*cf.* Situngkir, 2008). The latter is highly related to the classifications and standard batik be it the *mbatik* conventions in *keraton* or the highly external influence of coastal cities (Sondari & Yusmawati, 2000). Frequently, as we can see in the appendix, these factors have emerged a unique and fascinating batik design.

3. Concluding remarks

The computer technique to support the innovation of traditional batik is considered as a new field, and it becomes possible when we use computer as generator motifs which constructed by using certain fractal generating algorithms. The interaction between generation process of motif using computer and the traditional technique of batik has been emerging many kind of innovative and unique batik design. Certainly, computer techniques have opened many possibilities to support the innovation of the traditional heritage, such as Indonesian batik, while still holds the unique characteristics and feature of batik itself.

Generative motifs that generated by generating fractal algorithms need certain selection mechanism to determine whether the motifs is classified as an appropriate batik motifs or not. In our workshop, the participant could be easily interpreted most of generative motif as an appropriate batik motifs and then paint it using batik techniques. Human cognitive process and the cultural background of participant are considered have been playing an important role to influence such selection. However, it need a further analysis to answer such question ,i.e. about the mechanism in the human cognitive level as well as its cultural and anthropological aspects of participants to determine how certain motifs is perceived as “a beautiful” motifs.

The interpretation and implementations of generative motif to batik medium by artisan have emerging a lot of innovative batik design of traditional batik. The heterogeneity of human factors, that is its cognitive and her cultural process, plays an important role to emerging the innovative batik design. However, it remains need further analysis from many disciplines to obtain an understanding about the key process be it on individual level or social aspect related to creativity on cultural heritage artifact, such as batik.

Acknowledgement

We thank students of SMKN 14 Bandung involved in the workshop (names mentioned in the appendix) and their teachers Rini Ambarwati and Agus Edi Gunadi, Museum Barli for hosting the workshop. We also thank to our colleagues in Bandung Fe Institute, Indonesian Archipelago Cultures Initiative (IACI), and Bambang Subarnas for discussions. Finally, we realize that this research will never been conducted without financial support from Surya Research International. Faults remain on the authors.

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Appendix

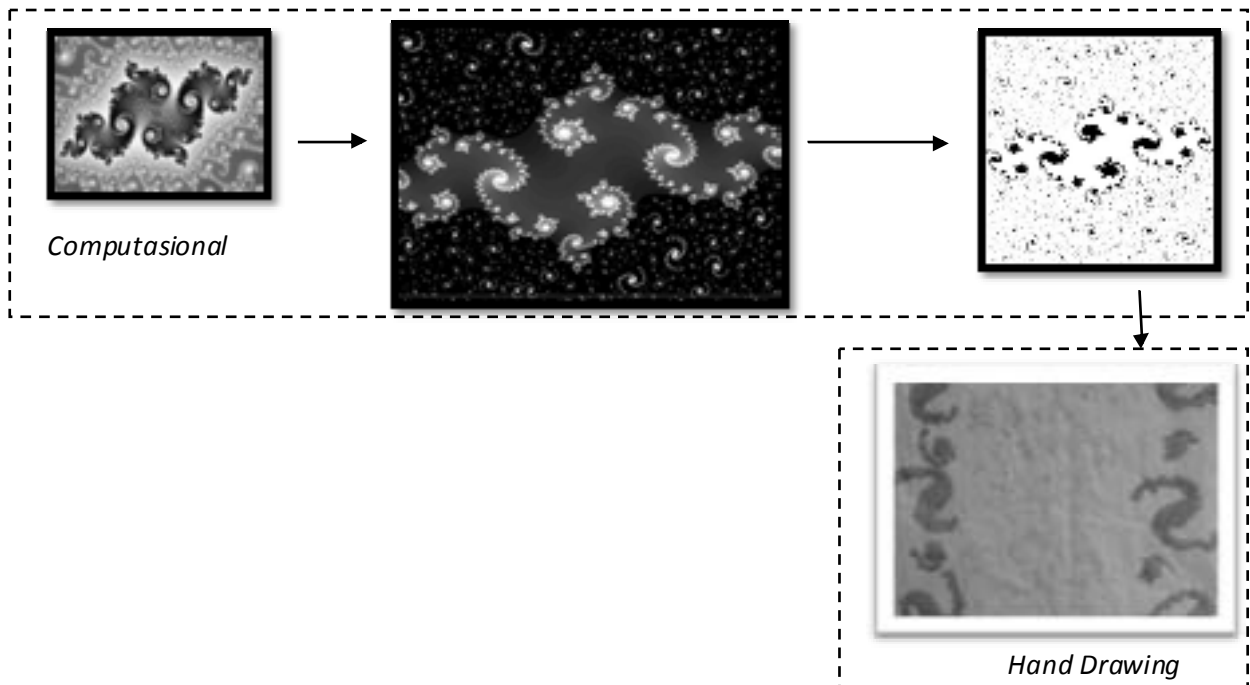
The interpretation of fractal generative motifs as batik motifs

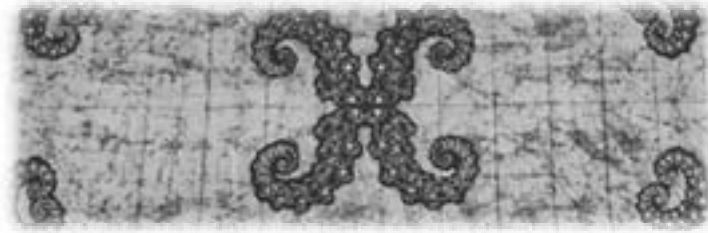


Batik Solituda Dulcinea

Finished by: *Iis Rosmini* (3rd grade student of 14 Senior High Proficiency School, Bandung)

It is considered as the *mbatik* (making batik) interpretation of particular Julia set Fractal that is generated by using the iterated function system of $z' = \sqrt{z-c}$, which c is complex constant. One of its two roots is chosen from iterated function system and afterward, z position is drawn continuously in every iteration on the complex plane. Batik motif produced here is filled with various spirals forming self-similar patterns with *isen* from part of Julia fractal.



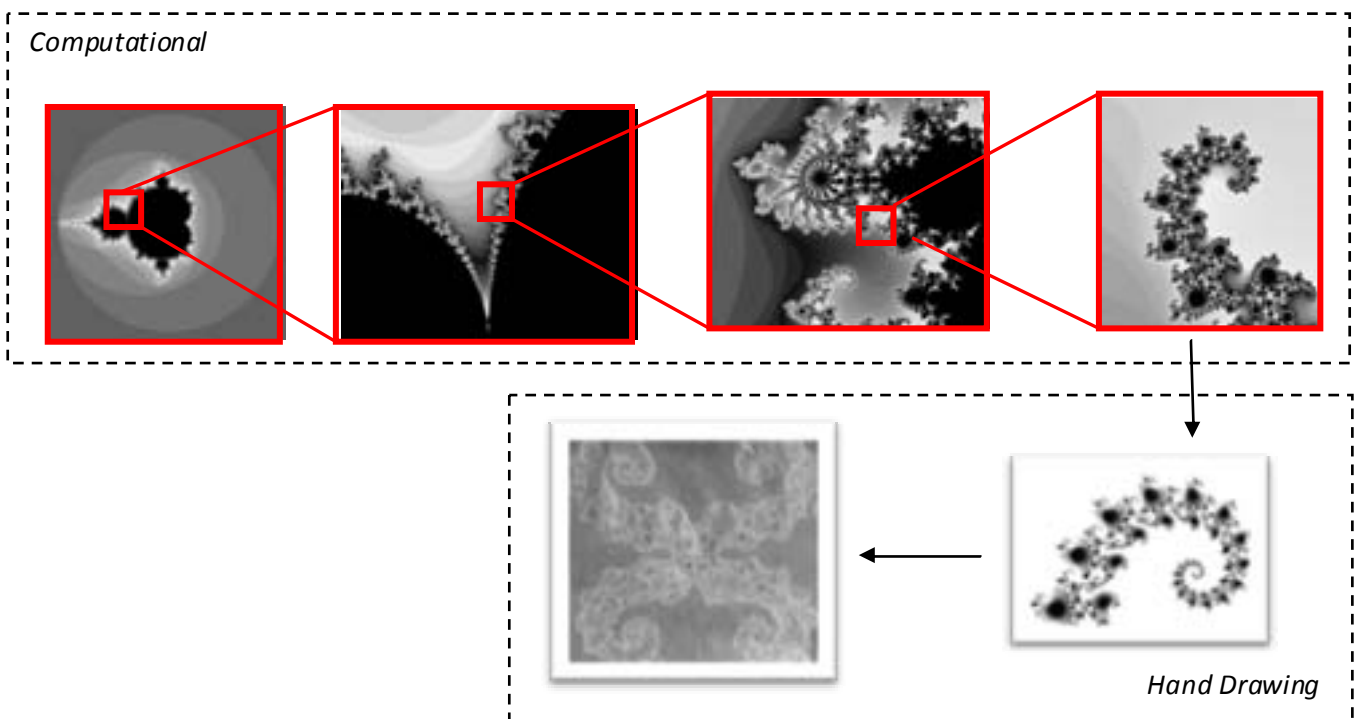


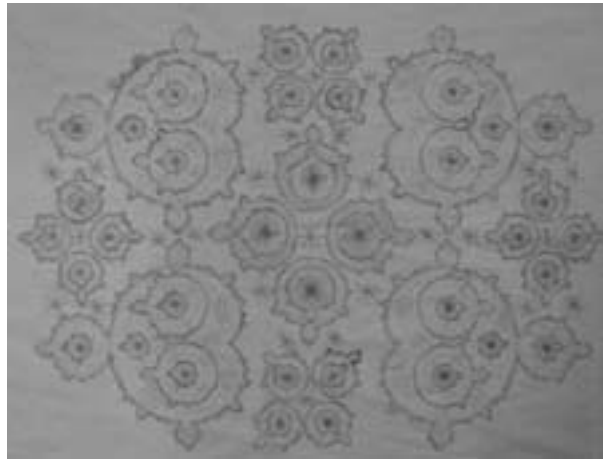
Batik Garuda Mandelbrot

Finished by: Fuji Akhriwati (2nd grade student of 14 Senior High Proficiency School, Bandung)

It is one of *mbatik* interpretation from a minor component of Fractal Mandelbrot set and in modern generative art often employed to draw phoenix pattern, a pattern that is also seen in traditional classical batik with Chinese influence. In *mbatik* interpretation that accomplished here, Garuda Mandelbrot motif is drawn by a unique harmonization of West Java, i.e. rocky (colored) patterns. This single pattern from phoenix-Mandelbrot set is arranged into *klowong*, it is apparently giving an artistic impression of typical Indonesian batik.

Pictures below are zooming out version from Fractal of Mandelbrot set that become an inspiration for Garuda Mandelbrot interpretation.





Batik Mandala Matematika

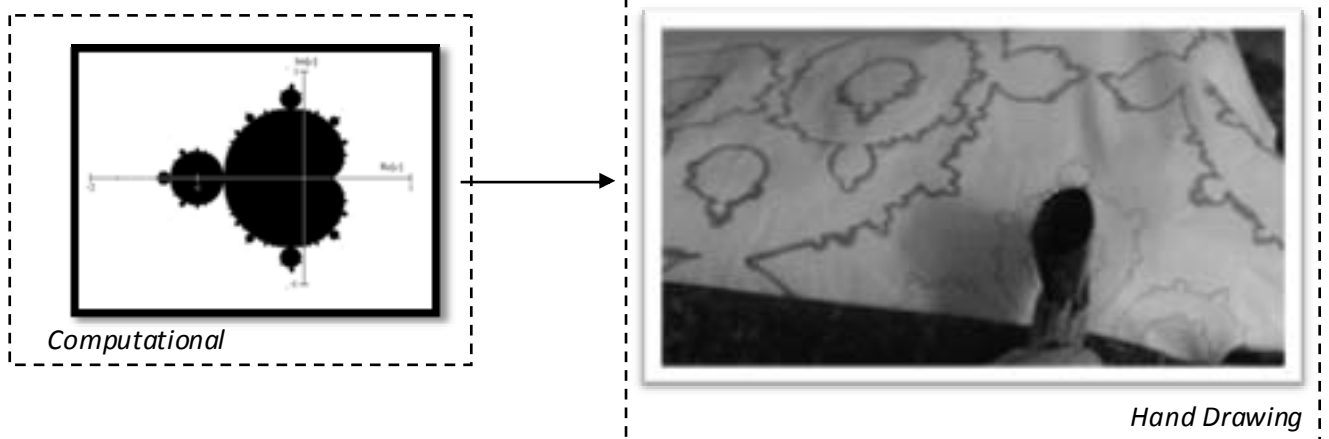
Finished by: Diana Anggraeni (2nd grade student of 14 Senior High Proficiency School, Bandung)

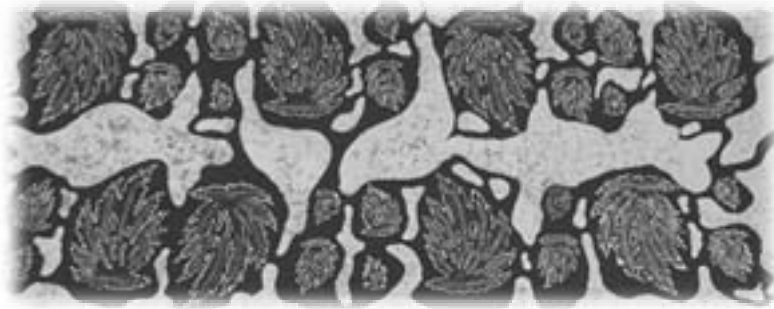
This is a spectacular *mbatik* interpretation of fractal Mandelbrot set. Mandelbrot set as the general form of Julia Set presented by Benoit Mandelbrot. The latter is the prominent mathematician in empirical work on modern fractal geometry. Mandelbrot set is a kind of generalization from Julia fractal that plot

$$\text{Mandelbrot} : z \rightarrow z^2 + c$$

With c as a complex parameter drawn in complex coordinate plane, $c = \text{Re}[c] + i\text{Im}[c]$, composed by two hyperbolic in left and right.

In this *mbatik* interpretation, generalization pattern of Mandelbrot set drawn with dilation of hundred pictures of Mandelbrot set. This design shows a fine arrangement that suitable to be called as *Mandala*.

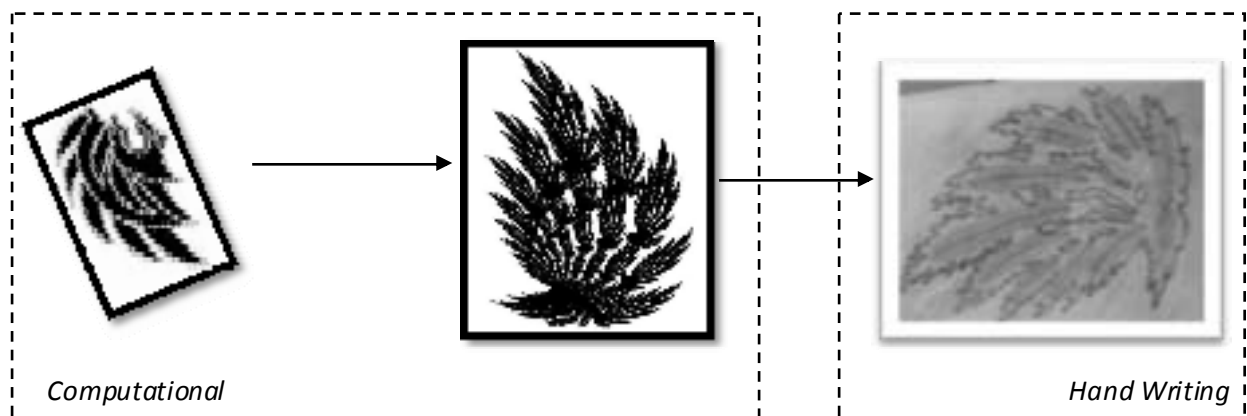


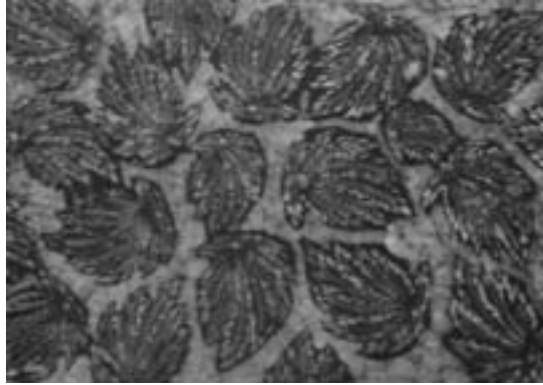


Batik Api Sangkala

Finished by: Yani Sumawati (3rd grade student of 14 Senior High Proficiency School, Bandung)

Batik Api Sangkala is designed from *Klowongan* pattern of basic motif formed by modification on affine transformation of the Iterated Function System on *sawat* motif. A thing which also has been found in previous research as the whole geometric system are a pattern appeared from the continuously iterated form of its smaller part. Changes that made to some mathematic coefficient of the transformation matrix has produced the shape of the basic motif assigned with *isen* of parallel lines that yield certain aesthetic impression.





Batik Gugur Muda

Finished by: Nisa Prihatini (2nd grade student of 14 Senior High Proficiency School, Bandung)

The design of Batik Gugur Muda created from *klowongan* pattern of basic motif produced by Iterated Function System of modified affine transformation matrix basically forming the *sawat* (wings) that philosophically expresses “trustworthy mind”. However an aesthetic interpretation has related the generated form the red leaves pattern. Changes that made in its mathematical coefficients from the *sawat* transformation matrix shown in figure below,



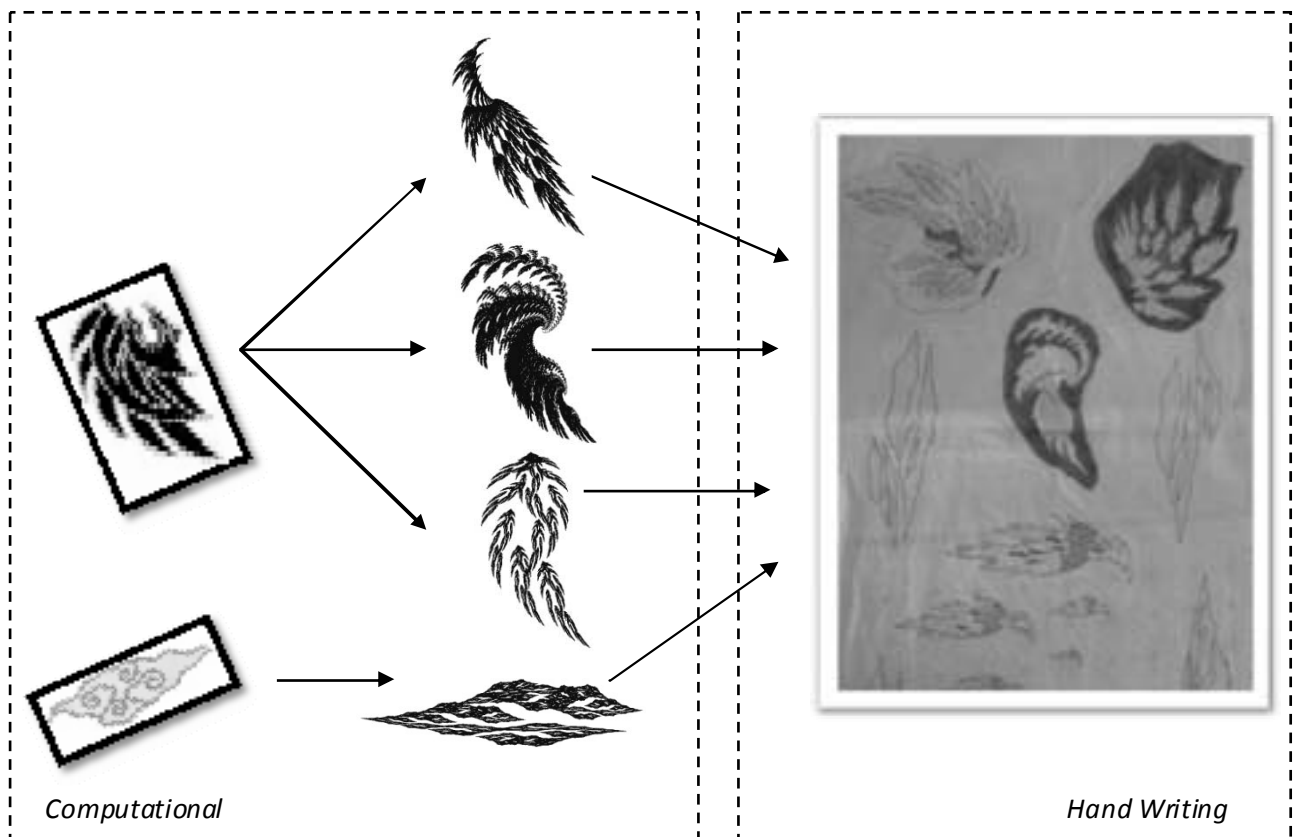


Gurdha Dirgantara

Designer: Pipih Sopiah (3rd grade student 14 Senior High Proficiency School, Bandung)

Klowongan of this design is created from the modification of the affine transformation matrix emerging the basic motif of *sawat* and *Mega Mendung* using iterated function system. This design gives impression of the unique batik ornamentation from coastal area.

From the general overview of the design, we can see a domination of the Cirebon drawing style in the design. It also can be seen from the cognitive and psychomotor transformation from the computationally generative motifs to the hand-made drawings with specific experiences of coastal style batik.



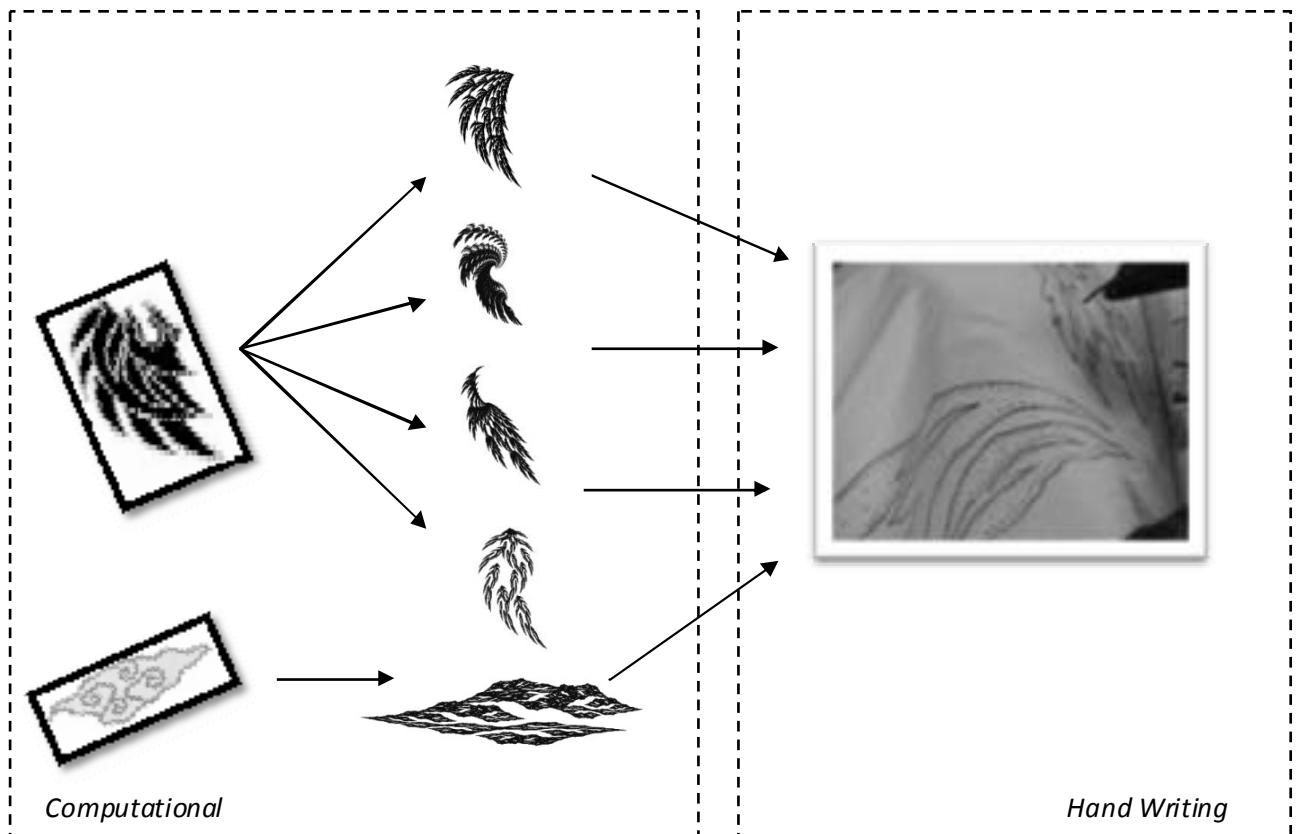


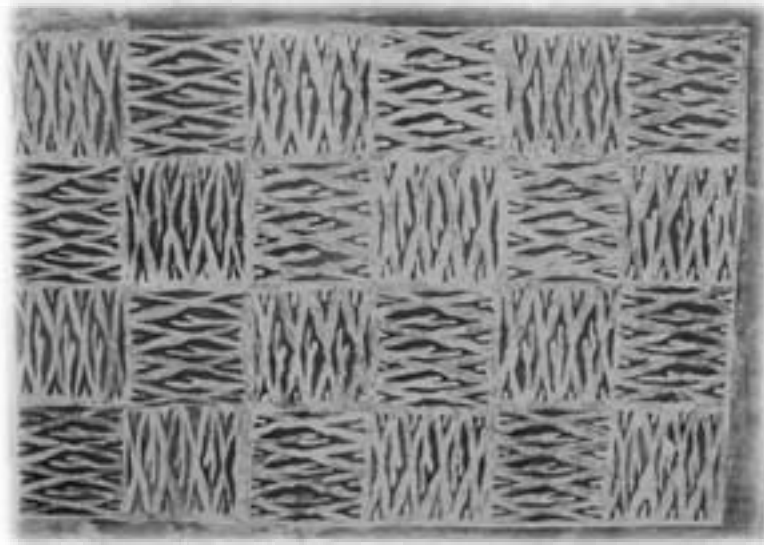
Tapa Pringgodani

Finished by: Ilah Sailah (2nd grade student of 14 Senior High Proficiency School, Bandung)

This motif design adopt the generative motif of *sawat* emerged from iterated function computation that form wings and birds, some of them combined with leaves ornamentation, while others are decorated with generative motifs resulted from transformative function of traditional Mega Mendung. Through its *cadasan* (rocky effect) that fills the finalizing harmonization (in diagonal form) and the coloring techniques has create a unique impression conventionally emerged while we gaze the traditional batik designs. The formation of this design generates new shape of wings and clouds in classical Javanese batik articulating both the *pedalaman* (royal *keraton* influence) impressions as well as the one from the coastal area.

The design of this batik has also been added with particular dot patterns inside the part of Mega Mendung as harmonization ornament, including the *sisikan* (fish-scale-like) form inside the generated wings motif. This creates an artistic impression through coloring technique between brown and violet.



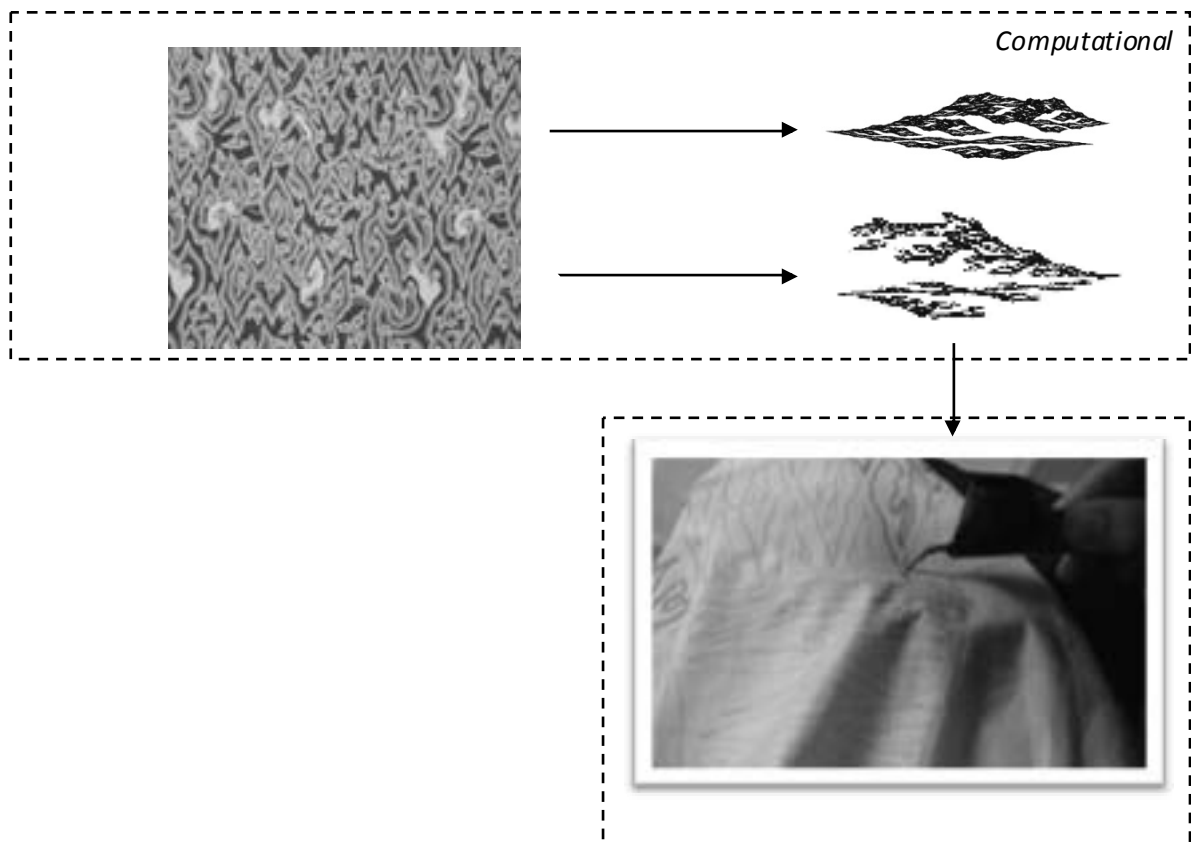


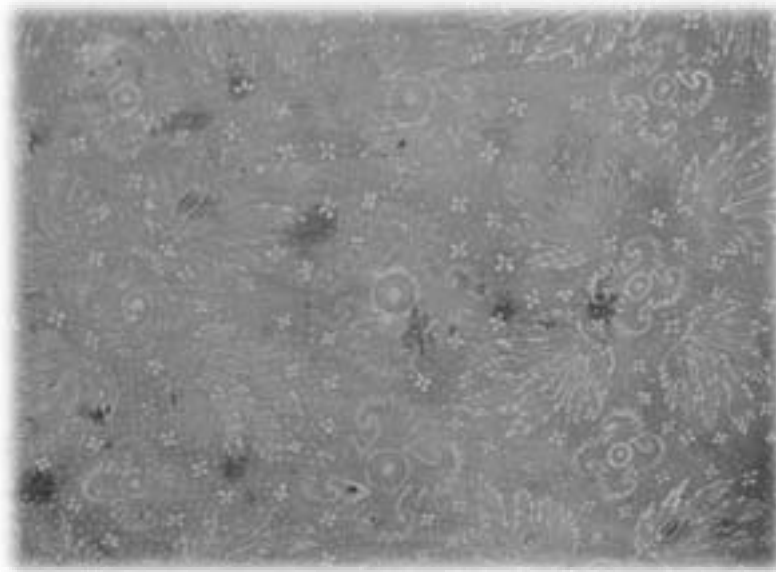
Mega Sisir

Finished by: Rani Quratalayuni (2nd grade student of 14 Senior High Proficiency School, Bandung)

This motif design presents a geometric re-composition of typical Cirebonan motif, Mega Mendung in arrangements in the square forms.

This motif design seems like following certain symmetric and geometric drift, whereas with detail observation we can find an interesting uniqueness on every square of which certain features – a common thing in typical characteristic of batik design. The design also harmonized by color gradation of violet and light brown.

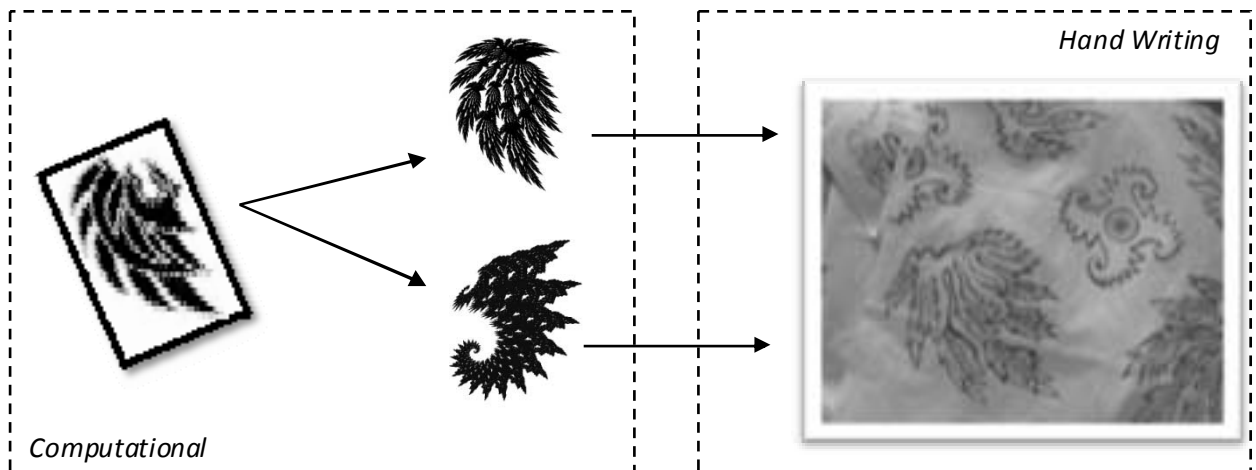




Batik Padang Laras

Designer: Rani Quratalayuni (2nd grade student of 14 Senior High Proficiency School, Bandung)

In Batik Padang Laras, wings innovations from basic motif of *sawat* is used as *klowongan*. This motif is generated through the iterated function creating floral forms. This motif becomes hybrid motif with dot and *nithik isen* that makes impression of herbals in the wild grass field. The violet spotted has given classical impression harmonized with brown color of this batik motif.





Batik Peksi Jaya Merdeka

Designer: Dede Eni (2nd grade student of 14 Senior High Proficiency School, Bandung)

This batik motif is a combination of two mathematical reconstructions emerged from the modifications to the affine transformation matrix of iterated function system related to the wings and Cirebon cloudy motif. The impression from two fractal wings motif then fills with rocky harmonization pattern presents *pesisir* (coastal area) pattern in the desired batik motif.

