Preserving the heritage of Central Sulawesi batik motif using fractal geometry concept

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Abstract. The heritage of Central Sulawesi batik have to be prevented in order to maintain Indonesian culture. Nowadays, available batik motif of Central Sulawesi needs to be explored to promote its cultural wealth. Using the main concept of fractal geometry, repetition and similarity, some motifs are designed in this research. The concepts make the motifs are displayed regularly. The base of the design is the diversity of the Central Sulawesi that located in Wallacea zone. This principal base makes the uniqueness of the motifs design. The generated motifs are varied by some parameters values that represent some mathematical operation and simulated by jbatik software. The operations are translation, rotation, dilatation, and reflection. This research results some motifs that are namely the waving cactus bloom, cesara, moringa chem, eboni herb, sigi fiesta, and harmony nature. The other advantage of the result is some motifs are also could be applicated as woven motif, the other Indonesian heritage clothing.

1. Introduction

Many part of Indonesia addresses to such unique heritage batik. Popular with Bomba motif that represents the welcome and togetherness of Central Sulawesi people, Palu does no exception [1]. The lack of its available motifs makes Bomba motif looks unfamiliar yet comparing to other Indonesian famous motif, such as javaneese motif i.e kawung, parang, lereng and sidomukti, or Handayani Batik Geulis Bogor i.e Paku-pakuan, Kijang Papasangan, Angkot, Bemo, Talas, Lereng Kujang Anggrek, Salapan Lawang, Tilu Sauyunan and Cepot. In this paper the heritage of Central Sulawesi batik will be prevented in order to maintain Indonesian culture by exploring its cultural wealth.

Central Sulawesi, located in Wallacea zone, has been given abundance of flora and fauna diversity. The beauty image of the diversity are very potential one that could be used as the base of the batik motif design. This principal base will flourishing the uniqueness of the designed motif result as described in the following consideration. Being the one of nonmetal excavation material that mainly stored in Donggala, quartz sand, actually has a beauty image of nano particle and become as the habitat of Salenopsis Geminata that cleverly obey to find the nearest distance of its path. Not only usfull as medicine, its nest image is but also could be used to enrich the constructed motif, as well as the chemical chain. A similar way in many other fields could be done to create much inspiring more motifs.

The aim of this research is to develope some motifs in order to prevent and to maintain Indonesian heritage culture. Using the main concept of fractal geometry, repetition and similarity, some motifs are designed in this research by some operations that are translation, rotation, dilatation, and reflection. The displayed motifs result are performed regularly as a consequences of geometrical concept stated in [2] and [3]. To make such accepted motif, some parameter values are generated and varied by some mathematical operations and simulated by jbatik software in [4]. Akbar used fractal in [5] to reconstruct some traditional weaving motifs of Central Sulawesi pohundo, taigania and cingkeh flower. Some other
discussion of fractal in the heritage of batik also finds in [6, 7, 8]. It also founded in [8] the pattern of *Frieze* and *Kristalografi* on “Kain Tapis” Lampung. Fractal is also used in [9, 10] to analyse the persistence of monthly rain fall in Pontianak in the time interval of 1987 – 2010 with a different identification system. Geometrical fractal aspect also founded in the heritage of temple and castle such as [11, 12].

The using of fractal applied in Central Sulawesi batik motif has impressed most of participants of Mathematics Teachers Webinar 2020 organized by Mathematics Study Program of Tadulako University in exploring mathematical method learning supported by Gadjah Mada University. The method is an alternative method that give opportunity to the teacher to be a facilitator in learning process. The basis of the method is realistic learning method with a student learning center approach. An active classroom situation generated by the method is a good training habit needed by students in forming students attitude and enterpreneurship. Those soft skills are the most important needed by mathematicians in some various career.

2. Materials and Methods
The materials used to develop the local enriched motifs are the nature resources, endemical flora- fauna and characterized identity of Central Sulawesi. The materials are organized in some hierarchical steps that are validating, selecting and categorizing data; representative profile determining and visualization; motive construction; harmonized, fitted and suited trials; and represented motive determination. The validating steps results some selected valid data of the vision – mission and characteristic identity of study programs of Mathematics and Natural Sciences Faculty, endemical flora – fauna and natural resources of Central Sulawesi. The valid data are selected and categorized using the guidance of the batik motif design concepts area scheme shown in Figure 1. A representative batik motif is resulted after considering the harmony and the fitness of content valid data for some trial and error construction design. As an example the motif of taiganja, pohundo and cingkeh flower shown in [5] are some examples motifs that comes from the data of natural resources and culture that influenced by fractal in classic motifs of art by applying jBatik application.

The material of this research partly are refer to [13], that are the image of *Vestitaria Giseke Arecaceae*, *Grammatophyllum Scriptum Blume Orchidaceae*, *Spathoglottis plicata J.J. Smith Orchidaceae*, *Taccia Palmata Blume Taccaceae*, and *Eboni* (*Dyospiros Celebica*). Other materials are *Salenopsis Geminata* [14], *Ant Path*[15], *Cactus* [16], *Sinus* and *Cosimus Graphics* [17], *Moringa Leaves* [18], *Moringa flower* [19], *Isotiosianat profile* [20], *Dioscorea* [21], *Dyospiros Celebica* [22], *Pharmacyst logo* [5], and *The representation of the danger of Palu – Koro fault* [23]. Some other materials such as : Black quartz sand, White quartz sand, Nano particle, Ant nest, Chemical chain, are created using some mathematical operation.

![Figure 1. Batik motif design concepts area scheme](image-url)
The batik motif design start by determining the batik motif concept and identifying the component of motif that will be consider. Every component usually consist or several objects and composed in such parameter values of reflection, rotation, dilation, translation and transformation. For the maleo mileo motif (see Figure 2.e), the concept is representing the beauty and the phylosophi of the endemic Central Sulawesi bird profile under the perspective of milenials. Furthermore, the motif components are the profil of maleo and jasmine. Maleo components are described by several objects, that are eye, mouth, neck, body and tail (see Figure 2.a); jasmine components are described by its leaf and petal (see Figure 2.b). The jasmine components are used as the back ground of where some maleo components are placed that are repeated for some number of iterations (see Figure 2.c and Figure 2.d).

![Maleo Components](image1)
![Jasmine Components](image2)

(a) (b)

![Repeating Pattern](image3)

(c) (d) (e)

**Figure 2.** Processing step of batik motif design

Characterizations used in this paper are governed from several study programs of Mathematics and Natural Sciences Faculty profiles. Each characterized profile are represent the spesific item to be promoted to popularize the study programs and faculty.

3. Results and discussion

3.1. Mathematics natural sciences motif

The richness of Central Sulawesi could be described from its natural resources, for example is quartz sand located at Toli – Toli. The black and white quartz sand and nano particle images are characterized by Figure 3 as representation Physics Study Program of Mathematics and Natural Sciences Faculty Tadulako existence.

![Black Quartz Sand](image4)
![White Quartz Sand](image5)
![Nano Particle](image6)

(a) (b) (c)

**Figure 3.** The images of a. Black quartz sand  b. White quartz sand  c. Nano particle

To draw the harmony of all study programs of the faculty, the profile of Salenopsis Geminata, ant nest and ant path in Figure 4 are chosen to represent the existence of study program of Biology, Mathematics
and Pharmacy; while the existence of Chemistry study program is represented by the figure of chemical chain.

![Chemical Chain](image)

**(a)** ![Ant Nest](image) **(b)** ![Chemical Chain](image) **(c)** ![Anti Path](image) **(d)** ![Anti Nest](image)

**Figure 4.** The images of (a) *Salenopsis Geminata*, (b) Ant nest, (c) Chemical chain and (d) Ant path

Compounding the all component profiles in Figure 3 and Figure 4 results, for such parameter values of reflection and rotation, the harmony nature motif was constructed using jBatik as shown in Fig 10.a.

### 3.2. Mathematics study program motif

The Mathematics Study Program batik motif is characterized by its principle, that is to investigate the solution of real problem in a simplest way. Looking to the most founded plant nearby Tadulako University campus, the beauty look of cactus is chosen by composed it in sinus and cosinus wave graphycs (see Figure 5). Sinus and Cosinus function graphycs

![Sinus and Cosinus Graphs](image) **(a)** ![Cactus](image) **(b)**

**Figure 5.** The images of (a) Cactus, (b) Sinus and cosinus graphycs

Using jbatik software, such parameter values of translation, rotation and dilation gave the waving Cactus bloom motif are composed by the two components as shown in Figure 10.b.

### 3.3. Biology study program motif

The Biology batik motif is characterized by some endemic flora and fauna of Central Sulawesi. Areca *Vestiaria Giseke Areaceae* is an endemic Wallacea plant of tropical rain forest that life at 600–800m at height region. *Grammatophyllum Scriptum Blume Orchidaceae* is also an almost extinct endemic Wallacea orchid with black polcodot of yellow flower in Kulawi Central Sulawesi. Another endemic orchid species is *Spathoglottis plicata J.J. Smith Orchidaceae* that growth harmonically with some kinds of grasses, while *Tacca Palmata Blume Taccaceae* as an endemic yearly herbs with violet blacked green colour spreaded at Lore Lindu National Park Palolo, Saluki, Sadaunta, Toro. The profiles are figured as follow

![Endemic Plants](image) **(a)** ![Endemic Plants](image) **(b)** ![Endemic Plants](image) **(c)** ![Endemic Plants](image) **(d)**

**Figure 6.** The images of (a) *Vestiaria Giseke Areaceae*, (b) *Grammatophyllum Scriptum Blume Orchidaceae*, (c) *Spathoglottis plicata J.J. Smith Orchidaceae*, (d) *Tacca Palmata Blume Taccaceae*
Using jbatik software, such parameter values of reflection, rotation and dilatation gave the Sigi orchidaceae fiesta motif is composed by the four components as shown in Figure 10.c.

3.4. Chemistry study program motif
The Chemistry Study Program batik motifs are characterized by moringa as the valuable research of chemist field. In addition, moringa is also being the most popular traditional food ingredients. The motifs are represented by the compound of its leave, flower and chemical chain. Isotiosianat profile, an anti inflammation contained on moringa, is chosen representing the study program profile. For some aesthetics reason, besides triangle image, dot point also influence as the batik phylsofi. Dot point being the phylsofi art of batik that comes from the words of mba and tik (see Figure 7)

Figure 7. The images of (a) Moringa leaves, (b) Moringa flower, (c) Dot and Triangl, (d) Isotiosianat profile

Using jbatik software, such parameter values of reflection, rotation and dilatation gave the moringa chem motifs are composed by six components as shown in Figure 10.d.

3.5. Pharmacy Study Program Motif
Banggai yam (Dioscorea) is a plant of local staple food that uses in Sasampe traditional Banggai event conducted in Banggai, one of Central Sulawesi district. Considering potential Pharmacy Study Program batik motif, the crossection of Eboni (Dyospiros Celebica), has an artistic image to be used. The population existence of the most expensive endemic wood plant is almost extinct. Its cros section is very nice to be point out, besides Pharmacyst logo as a symbol of medicine and healing. The composed of endemic plants and the profile of the study program could be seen in Figure 8.

Figure 8. The images of (a) Dioscorea, (b) Dyospiros Celebica, (c) Pharmacyst logo

Using jbatik software, such parameter values of reflection and rotation gave the eboni herbs motif is composed by the three components as shown in Figure 10.e.
3.6. Geophysics study program motif
The Geophysics Study Program batik motif is characterized by the most popular geological fault of Sulawesi. The motif is represented by the compose of two faults and land color symbols. Palu – Koro fault path is the most active fault that passing Sulawesi. An esthetical earth colour of the island, that are red brick that represents soil colour and yellow as the symbol of the glory, are composed by black and white colours that represent the dangers of Palu – Koro fault.

![Figure 9](image.png)

**Figure 9.** The representation of the dangers of Palu – Koro fault

Using jbatik software, such parameter values of reflection, rotation and transformation gave the cesara motif are composed by the two components as shown in Figure 10.f.

![Figure 10](image.png)

**Figure 10.** (a) Harmony nature, (b) Waving cactus bloom, (c) Sigi orchidaceae fiesta, (d) Moringa Chem, (e) Eboni herb, (f) Cesara

4. Conclusion
Some new unique motifs of batik from Central Sulawesi had been designed. The motifs are named the harmony nature, the waving cactus, the moringa chem, the Sigi fiesta, the eboni herb and cesara using fractal geometrical concepts. The motifs respectively represent the profile of Mathematics and Natural Sciences Faculty, Mathematics, Biology, Chemistry, Pharmacy and Geophysics Study Program of Tadulako University. The novelty of this research lies in the use of batik design using some visuals of natural resources of Central Sulawesi. Many motifs are left for future work in case of many subjects...
area that still observed yet. Another great challenge is also found in digitalizing the weaving motif design of another heritage art design of Central Sulawesi, that is Tenun Donggala.

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