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Submission date: 21-Sep-2025 04:54PM (UTC+0700)

Submission ID: 2757088457

File name: ang_Batik_Motifs_Using_Turtle_Graphics_Algorithms-pages-edit.pdf (828.81K)

Word count: 5683

Character count: 28200

CONSTRUCTING BATANG BATIK MOTIFS USING TURTLE GRAPHICS ALGORITHMS

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11 **Abstract.** During the COVID-19 pandemic, many activities were carried out digitally, including storing batik motifs to maintain the cloth pattern's sustainability. The samples were Batang Batik motifs of grapes, *Jamblang Papat* and *Kawung Jenggol*. The study aimed to store batik motifs in the form of computer programs with turtle graphics algorithms to ease the batik motif delivery because of the smaller memory storage. Computer programmers are needed to create batik patterns similar to Batang Batik patterns. Python programming uses turtle graphics to paint curves and generate graphics. The results of this study indicated that Batang Batik motifs can be made using turtle graphics without losing the characteristics of the batik itself. This finding can be used for more efficient storage of memory. The quality was also good when it was scaled up and down. This study has successfully created Grape, *Jamblang Papat*, and *Kawung Jenggol* motifs using turtle graphics algorithms in Python. The picture quality of the turtle graphics-scaled reconstructed image was equivalent to that of a photo image.

Keywords: Batang Batik, grape motif, *Jamblang Papat*, *Kawung Jenggol*, turtle graphics algorithm.

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17 **Received:** 6 September 2023; **Accepted:** 17 November 2023; **Published:** 6 April 2024.

9 1. Introduction

In Indonesia, batik is believed to have existed since the Majapahit era and became very popular at the end of the eighteenth century or early nineteenth century. By considering the technique, batik can be classified into written and stamped batik. Up to the early twentieth century, the batik produced was written batik, while stamped batik was only known after World War I or around the 1920s (Susantio, 2019; Wahyuningsih *et al.*, 2014). This means that the technique of coloring with hot wax barriers has been known in Indonesia since ancient times (Aryani *et al.*, 2021; Pandanwangi, 2020; Sumarsono *et al.*, 2013).

Currently, everyone needs to store data in digital form for a faster communication process. Especially during the COVID-19 pandemic, most activities are carried out digitally, including data storage. This also includes storing batik motif data where data security factors, speed of time in accessing data and locations accessible to the Internet can be done within 24 hours. In this study, the batik motifs stored in digital form come from Batang city. Batang Batik is batik produced from Batang City, Central Java. This batik is famous for its intricate patterns and designs, created through the traditional

How to cite (APA):

Ratnadewi, R., Pandanwangi, A., & Prijono, A. (2024). Constructing batang batik motifs using turtle graphics algorithms. *New Design Ideas*, 8(1), 207-219 <https://doi.org/10.62476/ndi81207>

batik process using canting. Canting is a tool consisting of a handle made of bamboo and a tip made of copper to distribute hot wax onto the surface of the cloth. This tool gives typical characteristics in Indonesia batik (Damayanti *et al.*, 2023). The current condition of Batang Batik is increasingly worrying due to the decrease in people willing to produce this batik. It becomes a concern since the batik makers are the older generation and the new generation has a small interest in making batik. Thus, to maintain cultural sustainability, archiving batik is necessary. In the other hand, it requires a large amount of storage. To solve this issue, this present study provides a very small storage by using algorithmic motif creation.

Batang Batik is a cultural heritage that has existed since the kingdom period; only palace people were allowed to wear it. Due to era changes, its presence has been developed and everyone can wear it. Batang batik has various patterns and colors. The concept of motifs and uniqueness in the manufacturing process also gives it its own uniqueness. Batang batik has a darker sogen (golden yellowish) color pattern, which is more blackish or blackish brown. The motifs consist of geometric motifs and a mixture of free motifs. Nowadays, Batang Batik exists as classic and modern batik. The classic batik consists of *Jamblang Papat* and *Kawung Jenggol* motifs, while the modern one is known as *Grape* motif (Figure 1).

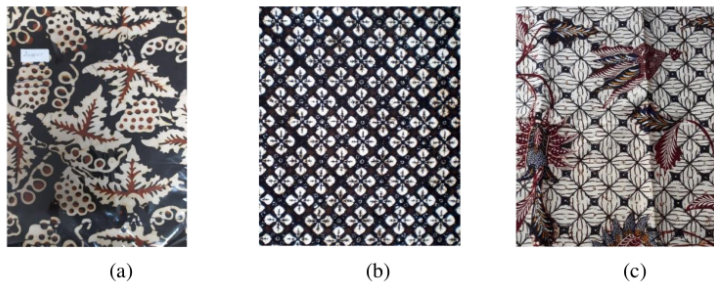


Figure 1. (a) The the grape motif; (b) the *Jamblang Papat* motif; (c) the *Kawung Jenggol* motif

The classic Batang Batik is also known as Rifa'iyah Batik. This name comes from the name of Kyai Rifai who lived during the Dutch colonial era. Kyai Rifai is a great scholar born in Tempuran Village, Kendal, Central Java, on 9 Muharram 1200 Hijriyyah or 1786 AD (Cipto, 2018). His desire to free the people from taxes at that time made the *kyai* finally invite the public to write poetry through batik (Aminah, 2016). In that era, the fabrication of Rifa'iyah Batik met difficulties in coloring, leading to exploring colors from other cities, namely Lasem, Pekalongan and Solo. Lasem was famous for its red color, while Pekalongan and Solo were famous for their blue and brown color, respectively. The combination of red, blue and brown introduced a new designation for Rifa'iyah Batik, called Batik Tiga Negeri.

Rifa'iyah Batik employs a combination of styles from three cities with Islamic patterns, making this batik unique (Aminah, 2016; Septiana, 2017). The characteristics of the motifs influenced by belief systems or religion and made and used by the Rifa'iyah Islamic community make this batik an identity of the local community (Septiana, 2017). Moreover, the acculturation of the touch of European and Chinese

colors and patterns makes this Rifa'iyah Batik a multicultural batik with the inclusion of the Islamic spirit (Cipto, 2018).

Rifa'iyah Batik influenced by Islamic teachings, is presented in Professor Ahmad Rifai's book, *Tarajumah*. One of his teachings prohibits depicting living things other than plants (flora) that misleads *aqeedah*, except those that are dead or have been cut off. If there is a picture of a living animal, it is *haram* to wear as clothing (Septiana, 2017). The teachings of Sheikh Ahmad Rifai became the basis and main characteristic for the decorations or motifs of Rifa'iyah Batik which seemed "floral". However, in Rifa'iyah Batik, there are animal parts (fauna) that have been distorted to resemble flora.

The long-used method of batik fabrication is dyeing with a technique called dye barrier technique that uses wax. This technique was discovered in Egypt and has been known since the fourth century BC, as shown by the discovery of mummy-wrapping cloth coated with wax to form a pattern (Supriono, 2013). In Asia, a similar technique to batik was used in India, China during the T'ang Dynasty (618–907) and Japan during the Nara Period (645–794). In Africa, the similar techniques to batik are known by the Yoruba Tribe in Nigeria and the Soninke and Wolof Tribes in Senegal.

Unfortunately, batik production using the Rifa'iyah methods has decreased in recent years. In 2018, only 87 of 100 craftsmen maintained their craft (2020 literature study data). The decline was due to Rifa'iyah's ignorance of the importance of cultural preservation and the lack of internal and external support. It is very important to keep cultural heritage from being forgotten over time. Socializing with alternative modes to express life lessons is also a must. Cultural heritage often uses images to convey its message to its viewers. This present study offers a solution to keep this cultural heritage by digitizing Rifa'iyah using turtle graphics. Thus, it can be well documented and implemented by the younger generation. The documentation can be done in the form of vector images. The advantage of using vector images is the good scaling to create better design quality with less memory and storage required. This study used the turtle graphics algorithm to form batik motifs in vector images.

1.1. Batang Regency

Batang is one of the batik-producing cities in Indonesia, located 8 km from Pekalongan City. Batang Batik has almost the same characteristics as Pekalongan Batik, but the color is darker (Binti & Sebayang, 2017; Dunn, 2016; Mustika, 2018). The difference is the use of *bang biron*. *Bang biron* is a term from the Javanese language, comes from the word "*abang*" which means red and "*biron*" which comes from the word "*mbironi*", means to make it blue. Meanwhile, Pekalongan Batik has cream as the background color in (Hayati, 2012). Batang is a regency (Indonesian: *kabupaten*) on the north coast of Central Java province in Indonesia. Batang Regency is located at 6° 51' 46" to 7° 11' 47" South Latitude and between 109° 40' 19" to 110° 03' 06" East Longitude on the north coast of Central. Its capital is the town of Batang, about 100 km west of the province's capital city of Semarang. People in Batang are mostly Javanese who speak both Javanese and Indonesian. The regency comprises both coastal and mountainous landscapes. Batang's town center is located on the side of the north coast trans Java highway network, widely known as "the Pantura" (Figure 2).

Source: (Map, n.d.)

This research used turtle graphics adop

Research using the turtle graphic method is usually a university learning process that does not include content to develop emotional and humanistic values. In this study, students can make batik motifs with the turtle graph algorithm in Python, which is not usually used to create social values. To test the effectiveness of this approach, questionnaires were distributed to 126 students, of which 74% were boys and 26% were girls. The results showed that 55% of students were interested in learning art and turtle graphic training to make batik motifs. This activity can increase (1) the creative function of the brain that can be improved through learning batik motifs, (2) the ability of respondents who learn to make batik motifs to interact better in their social environment, and (3) the ability to make batik motifs which can be assessed from the shape, proportion and scale of the motifs made (Ratnadewi, 2021a). This research is interesting to observe because it can prove that the humanistic element implemented through student practical work by making batik motifs using the turtle graph algorithm in Python can be conducted. The study will provide an understanding of storing batik motifs in the form of computer programs with turtle graphics algorithms so that digital batik motif delivery is easier because the memory needed is smaller.

Many different approaches have been recommended to elucidate to students in digitizing batik using basic mathematical concepts underlying computer graphics and computer-assisted designs, starting from arithmetic to projective geometry and polar shapes and from tensor and tensor diagrams to geometric and algebraic products. This study suggested a different approach based on turtle programming (LOGO is a coding language that includes turtle graphics, primarily designed for instructing computer

science) and turtle geometry. LOGO and turtle graphics have been accepted as paradigms for teaching programming to students and have also been successfully used as the first language in teaching programming to new students at various colleges and universities (Ju *et al.*, 2004). However, despite these achievements, turtle programming and geometry are ignored mainly in college courses on computer graphics and computer-based designs. This article will promote turtle programming as an effective way to introduce basic concepts of various disciplines for using turtle programming and graphics. The method pertains to cartesian coordinate planes and affine transformations, fractal curves, and iterative function systems, as well as fixed-point methods and techniques relaxation toward establishing Rifa'iyah Batik in data (Goldman *et al.*, 2004).

In the study, a survey of Batang Batik patterns was carried out through searching websites, online stores and partner references. The patterns of the Batang Batik were then collected, observed and created in a computer program that autonomously formed the Batang Batik pattern. The resulting batik pattern was compared with the existing Batang Batik pattern. If the pattern did not match, the computer program would be regenerated. This step was repeated until the results of the Batang Batik pattern from this autonomous program were similar to the existing Batang Batik pattern. Of course, computer programmers' artistic skills are needed to create batik patterns that are similar to the existing Batang Batik patterns.

To paint curves and generate graphics, Python programming uses a feature called turtle graphics (Saslow, 2018). Turtle is a library in Python for drawing graphics. After the turtle library is imported, graphic movements can be done to move forward, backward, right, left, etc. When combined with another command, these movements will create a different shape, so many graphics or patterns can be expected.

Some simple turtle commands (Elance, 2019) are as follows:

- a) Forward (10) = F(10) = FFFFFFFF is to move the turtle (arrow) forward by 10 pixels.
- b) Backward (5) = B(5) = BBBB is to move the turtle (arrow) back by 5 pixels.
- c) Right (35) = -δ(35) is to move the turtle (arrow) clockwise at an angle of 35 degrees.
- d) Left (55) = +δ(55) is to move the turtle (arrow) counterclockwise at an angle of 55 degrees.
- e) Go to (x,y) to move the turtle (arrow) to position x, y.
- f) Penup () = Up is to disable the pen so that when there is movement of the turtle (arrow), it does not create a graph.
- g) Pendown () = Down is to activate the pen so that when the turtle is moved (arrow), it will create a graph.
- h) X → FFF -δ(5) is looping a program containing forward three times and turning right 5 degrees.

The programming language used is Python in Google Collaboratory-based algorithm turtle graphics of Lindenmayer systems. This programming language can be accessed free of charge, which is expected to spur the younger generation to learn. The method in this research is descriptive quantitative and qualitative. The making of turtle motifs is described in the following steps and descriptions.

Before drawing the graph turtle, the batik motif was sketched on paper and then the graph equation would be found. The turtle command can move forward and draw a line or without drawing a line, turn left with angle δ , turn right with the angle δ , record



et el., 2019).

different conditions when drawing more complex batik motifs.

example can be seen in Figure 4.

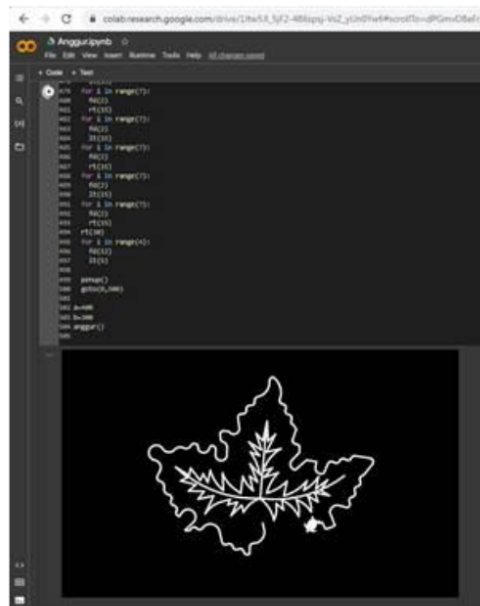


Figure 2. Screenshot application Collaboratory Google for making grape leaf batik motif

A reverse generative is used, namely, Batang Batik, which already exists from the local wealth of the Batang area and with turtle graphics, a pattern is formed (Tempel, 2017). Batang Batik was written as a program using Python with the turtle graphics algorithm stored in a file with the format*.ipynb. The color documentation was done by storing the red, green and blue values, as the text memory needed was only 1KB. The Batang Batik motifs are detailed and can be divided into classic and modern batik. The difference between classic and modern batik lies in the color, meaning, aesthetics and how it is made. Figure 5 and Figure 6 show the survey data.

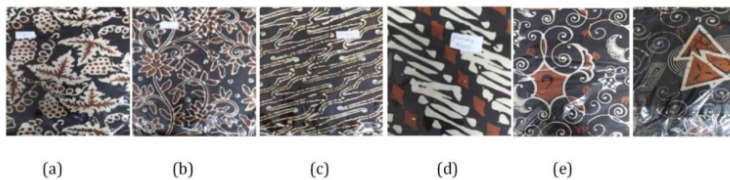


Figure 5. Modern Batang Batik motifs



Figure 6. Rifa'iyah motifs

3.1. Grapes Motif of Batang Batik

The grape motif was chosen because grapes are often found in the local area and have many benefits. The distinctive shape of the grapes in the form of small circles and the attractive shape of the leaves, coupled with the shape of the threaded stems, make this an inspiration for making batik motifs. The batik motifs in the form of grapes are beautiful and very interesting. This is why the grape motif is made into a batik motif. The motifs are visualized with the shape of a grape composed randomly, made with a pattern that repeats to the left, to the right or reversed and positioned at the top or bottom. Figure 7 shows Grapes motif of Batang Batik.

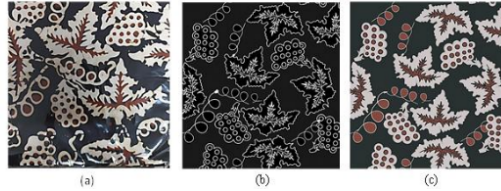


Figure 7. (a) Photo of Grape motif of Batang batik cloth, (b) the edge of Grape motif obtained from the program using the turtle algorithm (Ratnadewi *et al.*, 2021b) and (c) the reconstructed grape batik motif after coloring

The following is an example of an algorithm for making the left, right, middle stalks and leaf edge of the grape leaf batik motif (Figure 7(b)).

define grape_leaf():

a = 400

b = 300

Left stalk : Up, goto(a,b), Down, + $\delta(90)$ X(9)

X $\rightarrow$ FFFFFFFFFF FFFFFFFFFF - $\delta(5)$

Right stalk : Up, goto(a,b), Down, - $\delta(140)$ X(9)

X $\rightarrow$ FFFFFFFFFF FFFFFFFFFF + $\delta(5)$

Middle stalk : Up, goto(a,b), Down, + $\delta(45)$ F(150)

Left little stalk: Up, goto(a,b), Down, + $\delta(115)$ X(9) - $\delta(140)$ F(15) + $\delta(120)$ F(30) - $\delta(160)$ F(30) + $\delta(130)$ F(20) - $\delta(130)$ F(12) + $\delta(130)$ F(15) X(9) - $\delta(175)$

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F(40) +δ(127) F(32) -δ(140) F(20) +δ(127) F(32) -δ(140) F(20)
+δ(127) F(32) -δ(140) F(15) +δ(112) F(32)
X → FFFFF, +δ(5)
Left top little stalk: -δ(170) F(32) +δ(110) F(15) -δ(130) F(32) +δ(120) F(15) -δ(130)
F(20) +δ(140) F(25) -δ(150) X(7) +δ(130) F(35) -δ(160) V(6) F(20)
+δ(120) F(35) -δ(150) V(6)
X → FFFFFFF, +δ(5)
V → FFFFFFF, +δ(5)
Left middle stalk: +δ(140) F(30) -δ(140) F(20) +δ(150) F(40) -δ(160) F(30) +δ(150)
X(5) -δ(150) F(20) +δ(150) F(35) -δ(160) F(30) +δ(140) F(35) -δ(155)
F(20) +δ(125) F(40)
X → FFFFFFFF, +δ(5)
Right middle stalk : -δ(165) F(40) +δ(130) F(20) -δ(160) F(40) +δ(130) F(30) -
δ(160) X(7) F(10) +δ(130) F(20) -δ(150) F(25) +δ(150) F(30) -δ(150)
V(6)
X → FFFFFFF, +δ(5)
V → FFFFFFF, +δ(5)
Right top little stalk: +δ(120) X(6) -δ(150) F(32) +δ(120) X(7) -δ(160) F(20) +δ(140)
X(5) -δ(160) F(25) +δ(140) F(30) -δ(160) F(25)
X → FFFFFFF, +δ(5)
Right bottom little stalk: +δ(90) F(20) -δ(160) F(30) +δ(120) F(20) -δ(140) F(25)
+δ(150) X(7) V(6) F(10) +δ(140) X(7) -δ(140) V(8) +δ(120) F(20) -
δ(140) F(20) +δ(140) X(7) -δ(140) V(8) F(4)
X → FFFFF, -δ(5)
V → FFFFF, +δ(5)
Leaf edge: Up, goto(a+5,b+50), Down, +δ(140) F(10) X(7) V(6) F(15) -δ(60) W(7)
V(7) W(7) V(7) W(7) F(20) Z(9) W(7) V(7) W(7) -δ(90) F(20) A(13)
F(10) -δ(70) W(7) V(7) W(7) V(7) J(6) C(6) W(7) A(7) D(15) A(7)
D(5) C(6) W(10) C(10) F(10) -δ(50) W(7) F(10) C(12) F(15) C(4)
F(10) -δ(50) F(10) W(7) F(10) -δ(45) C(10) F(20) W(7) V(7) W(7)
+δ(30) E(5) W(7) -δ(35) G(6) V(7) W(7) V(7) W(7) V(7) -δ(50) F(10) -
δ(50) F(20) V(7) W(6) F(10) -δ(40) F(20) C(9) +δ(40) F(30) -δ(50)
F(20) -δ(90) F(10) C(9) +δ(30) F(20) W(7) V(7) W(7) V(7) W(5) F(30)
W(8) F(30) -δ(40) V(7) W(7) V(7) W(7) V(7) W(7) -δ(25) F(15) A(7)
+δ(20) F(25) W(2) -δ(50) H(5) -δ(70) F(15) +δ(90) W(4) V(7) W(7)
V(7) W(7) V(7) W(7) V(7) W(7) -δ(30) I(5), Up
X → FFFFFFF, -δ(15)
V → FF, +δ(15)
W → FF, -δ(15)
Z → FFFFF, +δ(15)
A → FFFF, +δ(15)
J → FFF, -δ(15)
C → FFF, +δ(15)
D → FFFF, -δ(15)
E → FFFFFFFF, +δ(15)

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G→ FFFFFFFF, -8(12)

H→ FFFF, -8(5)

I→ FFFFFFFFFF, +8(5)

Figures 8 (a) and (b) show the quality of both the bitmap image and vector image after scaling to 1:2 against the original image. They have less clear-quality bitmap image edges, where the edges look blurry, but the vector image remains excellent image quality.



Figure 8. (a) Photo of the grape motif of Batang batik cloth after scaling to 1:2 and (b) the reconstructed grape batik motif after coloring after scaling to 1:2

3.2. Jamblang Papat Motif of Batang Batik

The shape of the circular pattern of *Jamblang Papat* became proportional when implemented into the Python program. The scale resulting from programming the Python motif was made with a scale of 1:1. Aesthetically, this batik motif is unity and has geometric harmony with several symmetrical patterns so it looks neat with the colors of the brown, blue and black saga (Figure 9) (Chung, 2020; Elance, 2019; Hayati, 2012; Ju *et al.*, 2004; Marom, 2017 Ratnadewi *et al.*, 2021a).

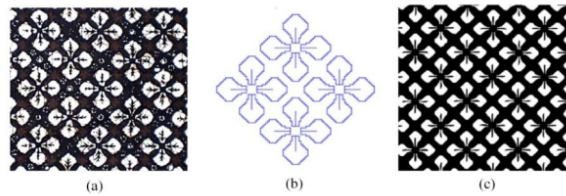


Figure 9. (a) Photo of the *Jamblang Papat* motif of Batang Batik, (b) the edge of the *Jamblang Papat* motif obtained from the program using the turtle algorithm (Ratnadewi *et al.*, 2021c) and (c) the reconstructed *Jamblang Papat* motif after coloring.

Figure 7(b) and after going through the coloring process in Figure 7(c). The result can be used for more efficient storage of memory. The quality of the results is also good when scaled.

Table 1 presents the comparison of the memory required for the storage motif. It appears that the memory needed to store the turtle motif on file *.ipynb is always smaller than the bitmap image storage.

Table 1. Memory storage for save picture or program

Types of motifs	Memory used for		
	*.py file memory	*.jpg image in black and white	*.jpg color image
Grapes	10 KB	113 KB	126 KB
Jamblang Papat	96 KB	6 KB	348 KB
Kawung Jenggol	2 KB	165	186

4. Conclusion

In this research, the Batang Batik motifs, such as grapes, *Jambang Prapat* and *Kawung Jenggol* were successfully created using turtle graphics algorithms in Python. The memory for storing motifs using turtle graphics in *.py format was smaller than storing images in the *.jpg format. The image quality of the reconstructed image scaled by the turtle graphics was better than the photo image. This turtle graphics batik motif can be used by traditional batik craftsmen when constructing initial drawings on the cloth. Then, batik craftsmen can color it with canting following the batik motif produced by the turtle graphics. The current generation can continue making batik by following batik motifs made with turtle graphics. The existing batik motifs can be preserved by storing the motif digitally with a small memory and good quality.

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