



# Media Development for Karawo Motif Design Using Genetic Algorithm Based on Gorontalo Regional Culture

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## **Authors' contributions**

*This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.*

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## **ABSTRACT**

The lack of karawo motif designs with a Gorontalo regional cultural philosophy causes karawo artisans to lack ideas to design karawo motifs in various design variations. One solution to overcome this is to create a media that can make several variations of the karawo motif design. The method used is an experimental method that consists of (1) preparing image data, (2) making geometric transformations, (3) developing a system using genetic algorithms, (4) implementation, (5) testing system, and Analyze media effectiveness. The drafting system is carried out using one image data, two image data, and three karawo motif image data. These data are then subjected to geometric transformations such as 45° rotation, horizontal flip, and vertical flip. Furthermore, the selection of transformation treatments is carried out by optimizing the fitness function in the genetic algorithm. Testing of the karawo motif arrangement system was carried out on one image data, two image data, and three image data. The N-Gain statistical analysis results from the initial trials and extended trials revealed percentages of 66.9% and 73%, respectively. These figures indicate the effectiveness of the developed media in enhancing the skills and knowledge of artisans in creating karawo motif designs.

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## 1. INTRODUCTION

Karawo cloth is a traditional cloth for Gorontalo residents who strives to continue to exist in today's increasingly modern era. Karawo comes from the Gorontalo language, which means hand embroidery or is known as handmade. Making karawo usually takes a very long time. On average, karawo artisans can finish creating karawo in up to 1 month or 30 days [1]. This fabric, with a high artistic taste, has been estimated to be occupied by the Gorontalo people since the 1600s. Karawo cloth has an aesthetic value consisting of a unity formed from all the decorative motifs displayed and is complex in manufacturing [2].

In 2013 the muri record was broken for the category of using karawo cloth by as many as 2,013 people. Another form was in 2016 for 1,250 Karawo embroiders [3]. The breaking of the karawo record coincided with the karawo festival, regularly held yearly to support the worldwide vision of karawo. In fact, in 2014, the Ministry of Education and Culture established Karawo as an intangible cultural heritage of Indonesia with the category of traditional skills and crafts [4].

Currently, the karawo motif design is still very monotonous and not innovative from the past until now. Idah Syahidah Habibie states this, as well as the Chairperson of the National handicrafts of Gorontalo Province when opening the karawo motif design development activity carried out by the Gorontalo Province SME Industry Trade Cooperative Service [5]. This is also supported by the statement of the head of the Gorontalo Province tourism office at the 2019 Karawo motif design training activity, which said that the karawo motif was still minimal and the karawo motif was identical to the flower [6].

Based on data from preliminary studies in interviews conducted at several karawo craft centres, Several artisans can create karawo, but they will have difficulty if the variations of the design requested are too many and must be different from the others. The lack of a karawo motif design based on the philosophical values of Gorontalo culture, makes karawo artisans have difficulty in making it.

In making the motif of a garment so that the design can be more varied, a technique is

needed in the form of a specific algorithm in its manufacture. Research related to karawo by Mulyanto et al. [7] and continued by Koniyo et al. [8] resulted in a design and application-based decision-making system that can adjust the primary human characters in the enneagram with the philosophy of the karawo motif. In line with this, research conducted by Badriah [9] and Rahman et al. [10] resulted in a system using the TSVQ (tree-structured vector quantization) and case base reasoning (CBR) methods that can create new patterns on woven fabrics and batik fabrics.

The Scale Invariant Feature Transform (SIFT) algorithm can also be performed in optimizing, diagnosing and determining the dimensions of images [11–15]. Research by Wibowo [16] uses the Scale Invariant Feature Transform (SIFT) method, which extracts features in the image to identify the types of Yogyakarta batik motifs. With the SIFT method, this type of batik can be introduced in an efficient way.

In making the motif of a garment so that the design can be more varied, a technique in the form of a specific algorithm is needed in its manufacture. Research by Prastyo & Mulyana [17] created a system for making batik patterns using the fractal method and the eight-way symmetrical circle algorithm. The same thing has also been done by Saefurrohman & Handayani [18], who made batik motif designs using the Fractal method and the L-System Algorithm. This technique is proven to be able to overcome the limitations of existing motifs. More and more motifs are produced, ranging from simple to unique shapes. Batik design innovation was also developed by Kusuma [19], who made batik designs from flowers combined with several alternative single, random, and radial directions. In addition, Pramestika & Hadi [20] made batik designs using Koch Snowflake's fractal geometry.

In addition to the above methods, there is an Interactive Evolutionary Algorithm (IEA) technique [21, 22] that has also been developed by Li [23] by creating an innovation in making batik motif designs that can capture the features in batik and create innovative patterns through the evolutionary process. Furthermore, Sun, Gong, & Zhang [24] developed an interactive genetic and semi-supervised learning algorithm to find solutions that ease the burden of user

evaluation to solve complex optimization problems in a large population. This technique is also supported by research by Johnson, McCormark, Santos, & Romero [25], which examines aesthetics and fitness measurement in evolutionary art systems. This research explains how to understand and apply fitness to explore the attractiveness, beauty, and creativity that the system can do.

Furthermore, Dou, Zong, & Li [26] and Dou, Zong, & Nan [27] research discusses interactive genetic algorithms that can overcome optimization problems by improving their fitness functions. Muzaqi's research also contributed to his research on the Evolutionary Art System (EAS), Evolutionary Computation (EC) and Genetic Algorithm (GA) methods in making batik motifs [28].

The lack of karawo motif designs based on the philosophical values of Gorontalo culture makes karawo artisans experience difficulties in making them. These things are the background of researchers in developing a system that can help artisans design karawo motifs with more variety and faster using computer technology using genetic algorithms.

## 2. METHODS

### 2.1 Research Design

The research method carried out is an experimental method with the following stages.

- a. Prepare initial data from cultural images of the Gorontalo region as image data for a karawo motif design.
- b. Geometry transformation  
Genetic algorithms are applied to determine the type of geometric transformation performed on the karawo motif image data.
- c. System development using genetic algorithm.  
The transformed image is then arranged to form a complete motif pattern. This study compiled karawo motif image data on one, two, and three images.
- d. Implementation system.  
This stage implements the results of the system design using a genetic algorithm into an interface that will be used by users in creating karawo motif designs.
- e. Testing systems.

In this study, testing of the karawo motif arrangement system was carried out on one image data, two image data, and three image data. Testing is done by generating each motif ten times.

- f. Analyze media effectiveness.  
This stage involves testing the product with small and large groups. Testing is carried out to assess the effectiveness of the media created.

### 2.2 Data Source

The data used in this research is image data which is the local culture of the Gorontalo region, namely images of musical instruments and traditional regional weapons totalling 27 images.

### 2.3 Data Analysis Technique

The effectiveness of media use can be observed from the increase in knowledge of karawo craftsmen through learning outcomes tests (pretest and posttest). To analyze media effectiveness, N-Gain analysis is used. Gain is the difference between the posttest and pretest scores. Hake's N-Gain test formula with an ideal score of 100 is as follows:

$$N\text{-Gain} = \frac{\text{Posttest score} - \text{Pretest score}}{\text{Maks score} - \text{Pretest score}}$$

After obtaining the N-gain value, data interpretation was carried out to assess the media effectiveness level categories as in Table 1.

## 3. RESULTS AND DISCUSSION

### 3.1 Images Data of Karawo Motif

This study uses 27 image data of karawo motifs, which will be compiled with various geometric transformation treatments to form a complete motif pattern. Some of the karawo motif image data used are shown in Fig. 1.

### 3.2 Geometry Transformation

Genetic algorithms are applied to determine the type of geometric transformation performed on the karawo motif image data. As explained in point 4.2 that the types of geometric transformations used include rotation, horizontal flip, and vertical flip. The transformation treatment value on the genetic algorithm is shown in Table 2.

**Table 1. Effectiveness level criteria**

No.	Achievement Rate (%)	Category
1	80 – 100	Very effective
2	66 – 79	effective
3	56 – 65	Effective enough
4	40 – 55	Less effective
5	0 – 39	Ineffective



**Fig. 1. Image data of karawo motifs**

**Table 2. Transformation treatment values in the genetic algorithm**

Treatment value in genetic algorithm	Types of Geometric Transformations
0	Not transformed
1	45° Rotation
2	Horizontal Flip
3	Vertical Flip

The transformed image is then arranged to form a complete motif pattern. In this study, karawo motif image data was prepared on one, two, and three images. The geometry transformations used include rotation, horizontal flip, and vertical flip. An example of the results of geometry transformation on karawo motif image data is shown in Fig. 2.

### 3.3 System Development using Genetic Algorithm

The transformed image is then arranged to form a complete motif pattern. This study compiled karawo motif image data on one, two, and three images. An example of the steps for applying the

genetic algorithm to three karawo motif image data is as follows:

#### 3.3.1 Determine the fitness function

3.3.1.1 The fitness function used is

$$f = w_1 * x - w_2 * y - w_3 * z \quad (1)$$

The first, second, and third images are different image data in this process. Where the image data is taken randomly from the database. The values of w1, w2 and w3 are determined by trial and error to obtain the results of selecting the optimal type of geometric transformation. In this process, the value of w1 is specified at 0.2, w2 at 0.3; while w3 is 0.4.







No	Types of Geometric Transformations	Original Image	Transformation Result
1	450 Rotation		
2	Horizontal Flip		
3	Vertical Flip		

Fig. 2. Example of geometry transformation result on karawo motif image data

### 3.3.1.2 Evaluating the fitness function

In this process, random number generation is carried out on the transformation treatment values for the first (x), second (y), and third (z) image data. The equation used in evaluating the fitness function is

$$x = (max_x - min_x) * rand(1,1) + min_x \quad (2)$$

$$y = (max_y - min_y) * rand(1,1) + min_y$$

$$z = (max_z - min_z) * rand(1,1) + min_z$$

$$f(x,y) = 0,2 * x - 0,3 * y - 0,4 * z$$

The fitness function is evaluated with as many as N chromosomes. In this research, the value of N = 4 is used. The command used to evaluate the fitness function is shown in Fig. 3.

### 3.3.1.3 Fitness value selection

The random number generation process in the fitness function evaluation is carried out four times to obtain four fitness values. The four fitness values are sorted, and the maximum

value is sought so that the f\_max value is obtained. The command is shown in Fig. 4.

### 3.3.1.4 Crossover

The transformation treatment values (x, y and z) obtained from the fitness function evaluation process are then crossed over to obtain the best value composition. The command used to perform the crossover is shown in Fig. 5.

### 3.3.1.5 Mutation

The mutation process is carried out to replace a generation with a new generation. Generation switching is done by generating random numbers at one of the transformation treatment values for the first (x), second (y), and third (z) image data. The command used to perform the mutation is shown in Fig. 6.

### 3.3.1.6 Survivor or replacement selection process

After generating random numbers in the mutation process, N chromosomes are selected from a combination of the previous populations. The selected N chromosomes will be used as the population for the next iteration or iteration. The command used to perform the mutation is shown in Fig. 7.

```
% fitness evaluation
for i = 1:4
    x(i) = (max_x - min_x)*rand(1,1) + min_x;
    y(i) = (max_y - min_y)*rand(1,1) + min_y;
    z(i) = (max_z - min_z)*rand(1,1) + min_z;
    fit(i) = (feval(f,x(i),y(i),z(i)));
end
```

Fig. 3. Evaluate the fitness function

```
cycle = 10;
iteration = 1;

while iteration < cycle
    % selection
    array = [fit(1) fit(2) fit(3) fit(4)];
    [sorted,index] = sort(array,'descend');
    fitness(iteration) = fit(index(1));
    no(iteration) = iteration;
```

Fig. 4. Fitness value selection command

```
% crossover
x(index(3)) = x(index(1));
y(index(3)) = y(index(2));
z(index(3)) = z(index(1));
x(index(4)) = x(index(2));
y(index(4)) = y(index(1));
z(index(4)) = z(index(1));
```

Fig. 5. Crossover command

```
% mutation
rand_num = randi([1 3],1,1);
if rand_num == 1
    x(index(4)) = (max_x - min_x)*rand(1,1) + min_x;
elseif rand_num == 2
    y(index(4)) = (max_y - min_y)*rand(1,1) + min_y;
else
    z(index(4)) = (max_z - min_z)*rand(1,1) + min_z;
end
```

Fig. 6. Mutation command

```
for i = 1:4
    z(i) = (max_z - min_z)*rand(1,1) + min_z;
    fit(i) = (feval(f,x(i),y(i),z(i)));
end
iteration = iteration + 1;
end
```

Fig. 7. Replacement selection command

### 3.3.1.7 Termination of iteration

The loop will stop when the number of cycles is reached. In this study, a cycle value of 10 was used. When the loop stops, the optimum fitness value is obtained. This value is the value of the transformation treatment, which will later be applied to each image data. The

command used to get the optimum fitness value is shown in Fig. 8.

## 3.4 Implementation system

The results of implementing this genetic algorithm can form several motifs, as shown in Fig. 9 and Fig. 10.

```
out = [round(x(index(1))),round(y(index(1))),...
      round(z(index(1)))];
```

Fig. 8. Command to get the optimum fitness value



Fig. 9. System interface with two data images of karawo motifs

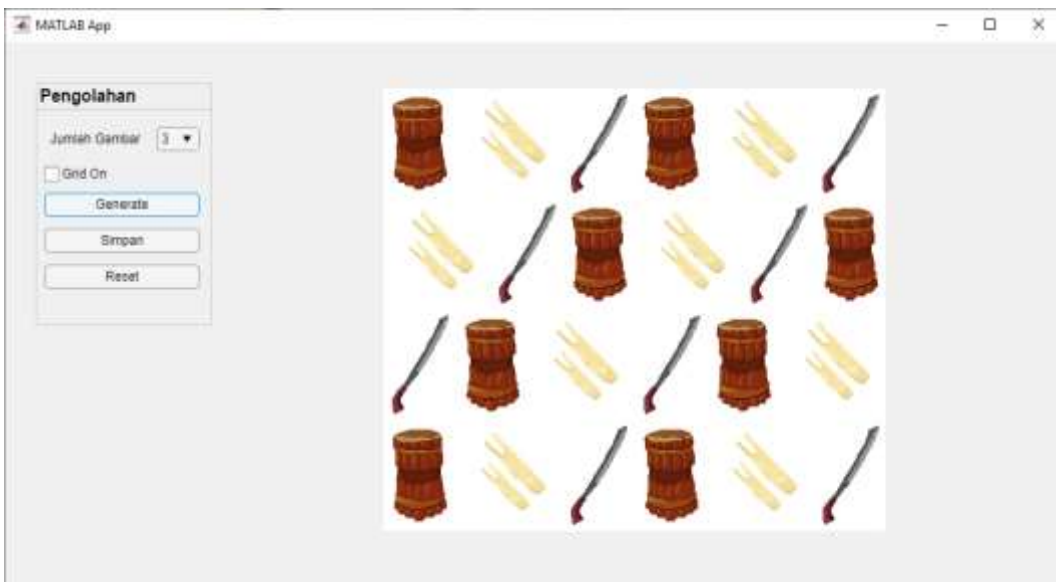


Fig. 10. System interface with three karawo motif image data









The application interface display comprises 1 panel and 1 axe. The description of each component is panel, 1 popup menu, 1 checkbox, 3 buttons, shown in Table 3.

Table 3. Description of each component application

No	Component Name	Description
1	Panel	Components for placing popup menus, checkboxes, and buttons
2	Popupmenu	Component for selecting the amount of karawo motif image data you want to use
3	Checkbox	Component to activate and deactivate the grid on the axes
4	Button	Components for generating karawo motifs, saving generated images, and resetting the interface
5	Axe	Component for placing the image generated by the karawo motif



**Table 4. Results of generating karawo motifs against three image data**

Gen	Treatment Value	Types of Geometric Transformations	Before	after
1	[1 0 2]	45° Rotation (1) Not transformed (0)		
2	[2 0 1]	Horizontal Flip (2) Not transformed (0) 45° Rotation (1)		
3	[3 1 3]	Vertical Flip (3) 45° Rotation (1) Vertical Flip (3)		
4	[2 1 1]	Horizontal Flip (2) 45° Rotation (1) 45° Rotation (1)		

### 3.5 Testing Systems

In this study, testing of the karawo motif arrangement system was carried out on one image data, two image data, and three image data. Testing is done by generating each motif ten times. The test results table can be seen in Table 4.

Based on Table 3, it appears that the process of forming karawo motifs has been done well. This is indicated by four types of geometry transformation in the test results using either one, two, or three image data. The adjustments that were applied successfully included untransforming, rotating by 450 degrees, horizontally flipping, and vertically flipping. The utilization of several forms of geometric transformations leads to a greater variety in the development of karawo motifs, hence enabling users to effectively employ the resulting image. In a broader context, it may be posited that the development of the karawo motif holds promise, as it has the potential to enhance the creative industries and save the traditional textiles of the Gorontalo region.

### 4. MEDIA EFFECTIVENESS RESULTS

The results of N-Gain statistical analysis in limited trials and expanded trials obtained percentage values of 66.9% and 73% respectively. This value shows that the media developed is effective in increasing the competence and knowledge of craftsmen in making karawo motif designs.

### 5. CONCLUSION

This research has successfully built a karawo motif arrangement system with genetic algorithms. The karawo motif image data used is a total of 27 data sets. The arrangement system is carried out using one image data, two image data, and three karawo motif image data. The data was then subjected to geometric transformations such as 450 rotation, horizontal flip, and vertical flip. The results of the development of this media show that this media is effective in increasing the knowledge and competence of karawo craftsmen in making more varied karawo motif designs.

### COMPETING INTERESTS

Authors have declared that no competing interests exist.

### REFERENCES

1. Yahya L, Nurwan N, Resmawan R. Determining the Optimal Time for Making Karawo Embroidery Crafts Using Max-Plus Algebra, Vygotsky. 2022;4:1.
2. Hasan AD. Study Of Decorative Variety In Gorontalo Karawo Fabric In Aesthetic And Symbolic Elements, ARTic. 2019;3.
3. Gultom HE. Gorontalo Sets Record for Most MURI Sulam Karawo Students, Jakarta; 2016.
4. Ministry of Education and Culture, Determination of Indonesia's Intangible Cultural Heritage; 2014.

- Available:<https://kekulturan.kemdikbud.go.id/ditwdb/penetapan-warisan-kultur-takbenda-indonesia-2014/>.
5. Solihin A. Karawo Embroidery Craftsmen Need Title Regeneration; 2018.  
Available:<https://gorontalo.antaranews.com/berita/48842/dekranasda-perajin-sulam-karawo-butuh-regeneration>.  
[Accessed: 03-Feb-2022].
  6. Haris. 75 Craftsmen Participate in Karawo Motif Design Training; 2019.  
Available:<https://gorontaloprov.go.id/75-pengrajin-ikuti-bisnis-produk-motif-karawo/>. [Accessed: 21-Mar-2022].
  7. Mulyanto A, Rohandi M, Tuloli SM. Classification of Karawo User Characters for Gorontalo Culture-Based Motif Recommendations Using the Naive Bayes Algorithm, Gorontalo; 2013.
  8. Koniyo MH, Lamusu SA, Hadjaratie L, Bouty AA. Designing a Karawo Motif Recommendation Application Based on User Characteristics Based on Gorontalo Culture, no. November; 2015.
  9. Badriah U. Weaving Patterns Using Tree Structured Vector Quantization, Sepuluh Nopember Institute of Technology; 2010.
  10. Rahman A, Setyanto NW, Sulistyarini DH, Arifianto EY. Computer Aided Process Planning Software Engineering Based on the CBR Method to Assist the Batik Making Proces. J. Mechanical Engineering. 2012;3(3):421–430.
  11. Cheung W, Hamarneh G. Scale Invariant Feature Transform for n-Dimensional Images (n-SIFT),” Insight J; 2022.
  12. Al-Shurbaji TA, Alkaabneh KA, Alhadid I, Masa’deh R. An optimized scale-invariant feature transform using chamfer distance in image matching, Intell. Auto. Soft Comput. 2022;31:2.
  13. Long Z, et al., Motor Fault Diagnosis Based on Scale Invariant Image Features,”IEEE Trans. Ind. Informatics. 2022;18:3.
  14. Chen S, Zhong S, Xue B, Li X, Zhao L, Chang CI. Iterative Scale-Invariant Feature Transform for Remote Sensing Image Registration, IEEE Trans. Geosci. Remote Sens. 2021;59:4.
  15. Alamri J, Harrabi R, Ben Chaabane S. Face Recognition based on Convolution Neural Network and Scale Invariant Feature Transform, Int. J. Adv. Comput. Sci. Appl. 2021;12:2.
  16. Wibowo GS. Implementation of Scale Invariant Feature Transform in the introduction of Yogyakarta Batik, Bandung; 2020.
  17. Prastyo A, Mulyana T. Application of Batik Patterns Using the Fractal Method and Symmetrical 8 Way Circle Algorithm, J. Teknol. Inf. 2014;10(2): 1–9.
  18. Saefurrohman and D. Handayani. Batik Motif Design Using the Fractal Method and L-System Algorithm to Build a Wali Batik Library, J. Teknol. Inf. Din. 2016;21(1):42–51.
  19. Kusuma PD. Fibrous Root Model in Batik Pattern Generation. 2017;95(14):3260–3269.
  20. Pramestika P, Hadi D. Fractal Batik Design Innovation using Koch Snowflake Fractal Geometry, Jember; 2019.
  21. Tomczyk MK, Kadzinski M, Decomposition-Based Interactive Evolutionary Algorithm for Multiple Objective Optimization, IEEE Trans. Evol. Comput. 2020;24:2.
  22. Leelathakul N, Rimcharoen S. Generating Kranok patterns with an interactive evolutionary algorithm, Appl. Soft Comput. J. 2020;89.
  23. Li Y. Innovative Batik Design with an Interactive Evolutionary Art System. 2009;24(6):1035–1047.
  24. Sun X, Gong D, Zhang W. Interactive genetic algorithms with large populations and semi-supervised learning. Appl. Soft Comput. J. 2012;12(9):3004–3013.
  25. Johnson CG, McCormack J, Santos I, Romero J. Understanding Aesthetics and Fitness Measures in Evolutionary Art Systems.pdf, Complexity; 2019.
  26. Dou R, Zong CM. Li. An interactive genetic algorithm with the interval arithmetic based on hesitation and its application to achieve customer collaborative product configuration design, Appl. Soft Comput. J. 2015;1–11.

27. Dou R, Zong C, Nan G. Knowledge-Based Systems Multi-stage interactive genetic algorithm for collaborative product customization, Knowledge-Based Syst; 2015.
28. Muzaqi S, Darujati C, Gumelar B. Batik Motif Design Design Using Genetic Algorithm Methods; 2018.

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