THE USE OF FRACTAL GEOMETRY IN TILING MOTIF DESIGN

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Abstract - In this paper I will present the use of fractal geometry to design tile motifs. A fractal is a geometric figure that combines the several characteristics among others: its parts have the same form as the whole, fragmented, and formation by iteration. The concept of fractals has been spread over all fields of sciences, technology, and art. This paper aims to provide an algorithm to creating motifs of tile algorithm for create the tile motif consists of base, iteration, coloration and duplication. In order to help the reader better understand the algorithm, I will present some script using Matlab. We describe a mathematically based algorithm that can fill a spatial region with sequence of randomly placed which may be transformed copies of one motif or several motifs. By using this algorithm, I can produce thousand variety of aesthetically pleasing tile motifs, of which we show a number of examples.

Keyword: tiles; fractal; symmetrical; iteration; duplication;

1. INTRODUCTION

Lately, the development of patterns for tile installation is getting more interesting. Many people try to make fresh breakthroughs and unique patterns so they don’t look monotonous. Patterned floor tiles, will make the residential look more extraordinary. With the best patterns, tiles combined with other accessories will make the house look more elegant and have character. There are many tile patterns or motifs that can be used at home. There are chess motifs, wood motifs, and there are also motifs such as broken rocks, and many more. Installation of tiles can be done in three places, the first is the tile on the porch of the house, the second tile on the inside of the house such as, living room, bedroom, kitchen and the third of course tiles located in the bathroom.

In terms of materials, tiles in Indonesian are made of clay. The next development is that there are types of porcelain or cement. In terms of shape, tiles develop in various forms such as hexagonal, parallelogram, or other shapes. So, no longer dominated by the rectangular shape which is a conventional form. Size also many variations. In terms of decoration, tiles generally consist of two colors, but there are also up to six colors. Decoration that arises is clay that is colored differently following the pattern that has been made. The pattern on the surface of the tile is not in the form of glaze, painting, or stamp with a certain color, but because of the different colors of clay. The use of tiles as a social function is seen when tiles are used in a place to distinguish social status, economic level, level of power, and so on[1]. Since the 1860s geometric floor tiles began to appear in Victorian public buildings, churches and villas and became a convincing and prestigious fashion for its users. By the 1890s these tiles had become important features that enhanced the prestige and appearance of Victorian-style spaces. This indicates that from the beginning this tile was placed in special or special places.
Palaces, churches and villas are places that have their own meanings or symbols for their owners or users. Especially relating to the symbol of power. The term Fractal was introduced in mathematics by Mandelbrot, who defines what is called Fractal Geometry [2,3]. This geometry is able to describe the irregular but beautiful shapes found by nature. Fractal Geometry is based on the use of the principle of repetition of geometric shapes, so that an object can reproduce itself when experiencing magnification. With Fractal Geometry, art can discover new creativity. Even with fractals, we can find new patterns that were previously unimaginable. With fractals, we don’t need to create shapes, we just need to do shape selection, because fractals will provide an infinite variety of shapes. In addition to the design of batik patterns [4,5,6], fields connected by fractal geometry are biology and medical imaging [7, 8, 9, 10]. Fractal geometry has also been used for data compression and modeling complex geological and organic systems, such as tree growth and river valley development. From these facts I have done research on how to make tile motifs using fractal theory.

II. ALGORITHM

In making tile motifs, the matrix bases is first formed. Base in the form of a two-dimensional matrix with continuous values that can be linear, sine, quadratic and others. To get a symmetrical pattern, the matrix bases value must also be symmetrical. This is an example of a symmetrical matrix bases in Matlab code:

```matlab
x = -5: 0.5: 5;
y = -5: 0.5: 5;
[X, Y] = meshgrid (x, y);
```

After the matrix bases is formed, the iteration function is performed. One of the iteration functions that worked well in my study was \( f(Z) = (X + Y)^2 + c \). This function has gotten beautiful results since the first iteration. If the number of iterations and \( c \) are given a random value, then each execution will produce a different image. This is an example of iteration in Matlab code.

```matlab
Z = (X + Y)^2 + rand;
pcolor (X, Y, Z);
interp shading
axis ('equal', 'square', 'off')
```

The most important phase is color filling. In principle, in Matlab, we can make a colormap matrix as we wish with random number for red (R), green (G) and blue (B) components. The black color can be obtained with a combination of RGB = 0,0,0. Brown color is obtained with a combination of RGB = 0.5,0.5,0. Yellow color is obtained by a combination of RGB = 1,1,0. And white with a combination of RGB = 1,1,1. The green color is obtained by a combination of RGB = 0,1,0. The combination of random numbers RGB = (Random, Random, 0) can produce reddish, brownish or greenish colors. In this program code, we will cover dark colors, so if all the color components are less than 0.5, then we will set the color to white. In Matlab, for this purpose an algorithm can be made as follows:

```matlab
makskolor=16;
for i=1:makskolor;
kolor(i,1)=round(rand);
kolor(i,2)=round(rand);
kolor(i,3)=round(rand);
if (kolor (i,1)<= 0.5) & (kolor (i,2)<= 0.5) & (kolor (i,3)<= 0.5)
kolor (i,1) = 1;
kolor (i,2) = 1;
kolor (i,2) = 1;
end;
end;
colormap (kolor);
```

Execution of the program code will produce a tile cell. Because in the market one cell motif is symmetrical, so the way to install one tile with another must be rotated to get a symmetrical pattern. In order to provide more insight, here I will provide another program that uses the function \( Z = Z^2 + c \). The tile pattern of the second program is not symmetrical. If you want to make a symmetrical tile, this cell must be reflected in the X-axis and Y-axis.

```matlab
clear;
x=-1:0.4:1;
y=-1:0.4:1;
[X,Y]=meshgrid(x,y);
```
Z=X+i*Y;
for k=1:3;
    Z=Z.^Z+rand;
    W=exp(-abs(Z));
end
pcolor(W);
shading interp
axis('equal','square','off')
maksolor=16;
for i=1:maksolor;
    rand2=rand;
    kolor(i,1)=rand2*0.75;
    kolor(i,2)=rand2*0.5;
    kolor(i,3)=rand2;
end;
colormap (kolor);

III. RESULTS AND DISCUSSION

In this research, the execution of the program has been carried out. Because it uses a random value, each execution produces a different pattern. From this program code, we can produce thousands of different tile motifs. We just need to select the motifs that we feel are subjectively beautiful. The sample of the tile motif that I produced can be seen in Figures 1, 2 and 3. The left image is a cell tile and the right image is a collection of tiles that have been joined, both symmetrical and asymmetrical tiles.

Figure 1. Sample of tile motif 1

Figure 2. Sample of tile motif 2
IV. CONCLUSION

The discovery of Fractal Geometry has made it possible to find thousands of beautiful tile motifs automatically so it is very fun. Fractals make it possible to better understand geometric figures with regular structures. By using Fractal geometry, we can play with large simulations without limits through a digital system. Thus, we can involve science in art and culture.

REFFERENCE